HEATING & VENTILATING
AIR CONDITIONING

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FOR MAY, 1937

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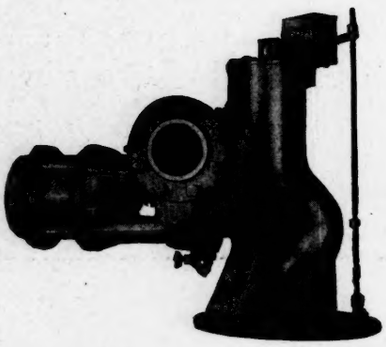

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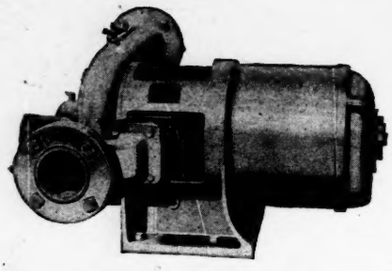

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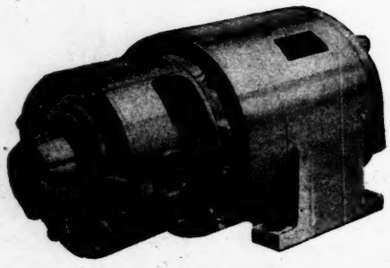

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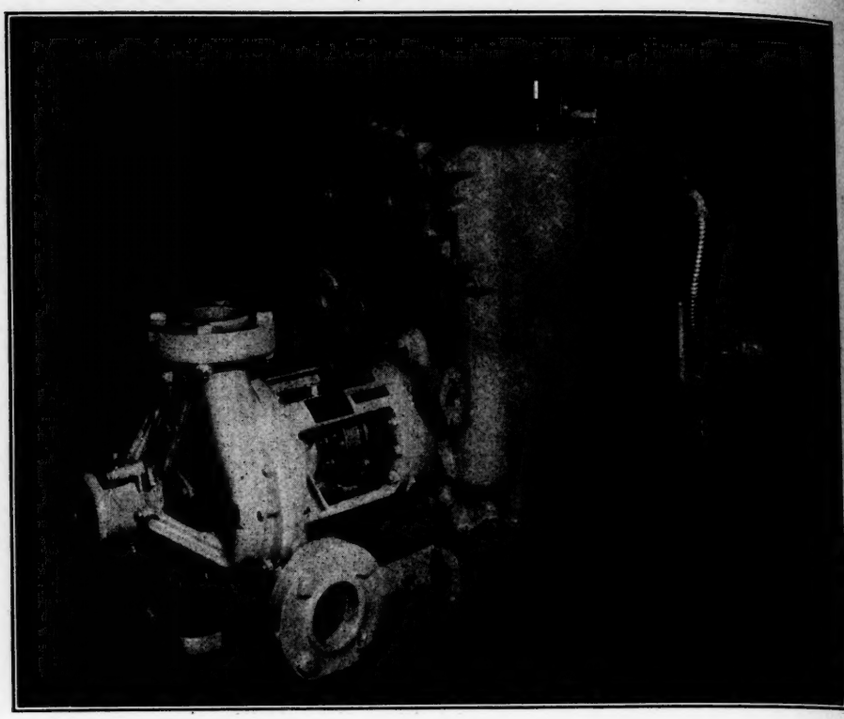

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Stanley S. Holmes Village project, Atlantic City, N. J., looking northeast, showing court in block B.

Low Rent Housing Project Heats with Hot Water

By JOSEPH F. KERN, Jr.†

THE most recent unit of the Federal Administration of Public Works' housing program to be completed is the Stanley S. Holmes Village in Atlantic City, N. J. This project which will house 277 families is in many ways typical of 50 other PWA projects under construction or completed in 35 cities and two insular possessions. It is the Government's purpose to make this housing program a national demonstration of slum clearance and low-rent housing. When the program is completed it is expected that nearly 25,000 families from a low income group will find comfortable and sanitary quarters in these buildings.

Less noticeable but of considerably more importance to future housing developments are the ideas and types of construction which have been incorporated in these projects.

The Stanley S. Holmes Village has been erected at a cost of $1,700,000 on an eight-acre site bordered by Kentucky, Adriatic, Illinois, and Baltic Avenues. There are 16 buildings in the village divided into two blocks of eight each. They are built in such a manner that all of the rooms have a plentiful supply of light and face either a street or a large landscaped courtyard.

Buildings vary in height from two to three stories and are of fireproof construction with walls of brick and tile. There are some 982 rooms in the project.

Located at a central point in the project and occupying one wing of a building is the central heating plant. This plant has been designed to supply forced hot water for heating and domestic hot water for washing to the 16 buildings in the village.

†Assistant Editor, HEATING & VENTILATING.

Design Practice

In designing the mechanical equipment the Housing Division of PWA has attempted to obtain the most economical system not only in first cost but also in long time costs. In other words they believe that the systems which they have designed will give the best combination of low first, operating, and maintenance costs. To achieve this result they have not hesitated to utilize new ideas and materials. In most cases, however, well known materials and time tried ideas have been employed.

In the Atlantic City project they have attempted to eliminate the human element in the control and operation of the plant so far as is reasonably possible.

Heating System

Hot water for the heating system is supplied to the various buildings by a system of underground and underfloor supply and return mains. The water is taken partly from the boilers and partly from the heating returns and is automatically mixed by mixing valves in proportions to deliver water at temperatures suitable to maintain proper room temperatures. Circulating pumps are used to force the water through the piping distribution system. Automatic vents remove the air from the distribution system where necessary.

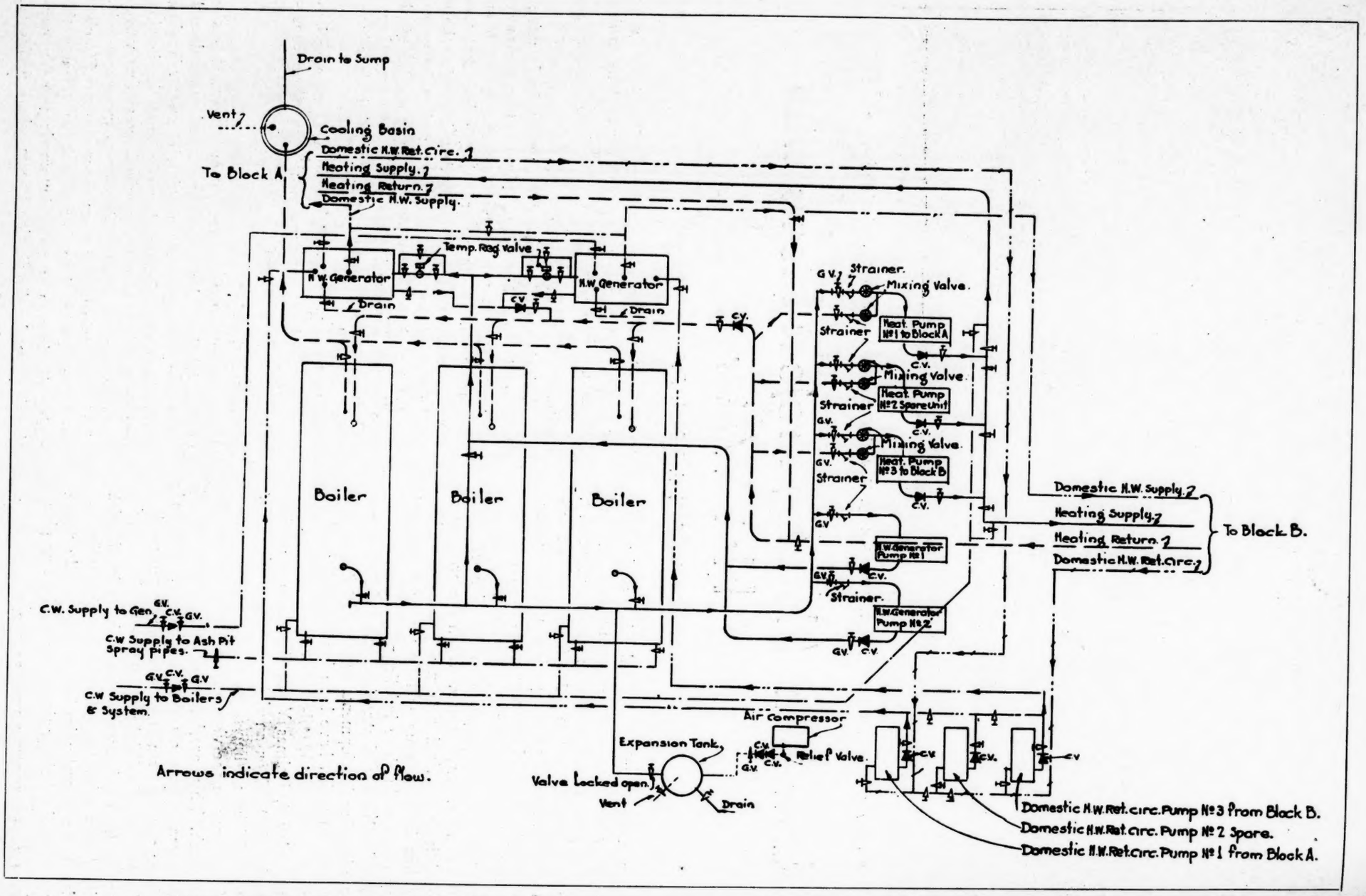


Diagram showing the arrangement of piping in the boiler room. Piping for both the hot water heating plant and the service hot water system are indicated. The drawing is not to scale.

The heating system in each building is a two-pipe, upfeed, reversed return, forced circulating system. A pressure differential control is provided in each building to maintain a constant pressure difference between the point where the supply main enters and the return main leaves. This is done so that the distribution of hot water to the various radiators is not affected by changes in the pressures of the distribution system.

Boiler Plant

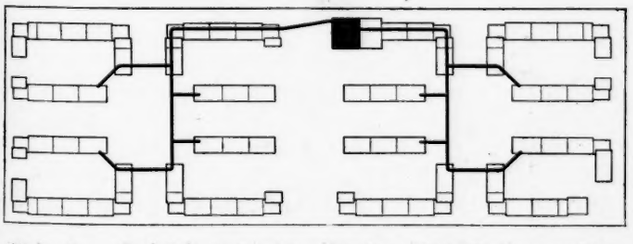
The boiler plant is located in the south end of building No. 4-A on the corner of Mediterranean and Illinois Avenues. It contains three 150-hp. steel hot water boilers together with necessary associated equipment such as mechanical stokers, expansion tanks, hot water generators, and coal and ash storage facilities. Two boilers will normally carry the load, the third being provided as a spare. In a room next to the boiler plant are located the various pumps necessary for the distribution of heating water and circulation and generation of domestic hot water.

The plant is designed to burn bituminous nut and slack coal. This coal is carried to the plant in trucks which are driven on to the roof of the coal and ash storage space only slightly above the ground level. The coal is dumped from the trucks through manholes in the roof and falls directly into the storage space. When coal is desired for the stokers it is loaded by hand into a coal bucket having a capacity of approximately 750 lb. This bucket is then wheeled to the boilers and is lifted by means of an electric monorail type hoist to the proper level. The bucket is then moved by monorail to the proper position over the stoker hopper where it is dumped by means of a suitable tripping device.

The stokers are all mechanical ram, automatic underfeed type provided with side dump plates. The electric motors operating the stokers can be controlled either by a magnetic pushbutton switch or by an immersion type water temperature control.

Ash removed from the boilers is stored in a small ash storage room until it can be removed from the plant by trucks. A telescopic electric operated ash hoist is used to lift the ash cans from the storage room to a position above the roof so that the cans can be dumped into trucks. The hoist has a capacity for handling 500 lb. at one time. Draft for the boilers is obtained from a 54-in. radial brick chimney 100 ft. high. All of the flue gases are passed through a cinder trap to remove cinders and soot.

The three boilers are of the horizontal return tubular type arranged to operate as hot water heating boilers.



Plot plan showing hot water heating distribution system. Solid black square indicates boiler plant.

They are capable of withstanding a pressure of 100 lb. per sq. in., and each has approximately 1500 sq. ft. of heating surface. The boilers are so controlled that they will supply water at a temperature of 230F to the heating system and hot water generators. Twin relief safety valves are provided on each boiler. Drains from each boiler are passed to a cooling basin which has a vent to the outdoors above the boiler roof. This basin serves to cool the water drained from the boiler so that hot water is not discharged directly in the sewers.

In one corner of the boiler room is a large expansion tank to provide for expansion and contraction of the water in the heating system. To maintain the proper pressure in the heating system a small motor-driven air compressor having a displacement of 2½ c.f.m. of air is connected to the expansion tank. The compressor is started by a pressure switch when the pressure in the tank drops to 20 lb. per sq. in. and is stopped when it reaches 26 lb. A twin relief valve on the tank relieves the pressure when it reaches 60 lb.

Pump Room

The various pumps for circulating the hot water are housed in a small room located next to the boiler room. There are eight pumps in this room—three heating water circulating pumps, two domestic water generator pumps, and three domestic hot water circulating pumps.

The 230F water from the boilers before going to the heating water circulating pumps is mixed with the heating return water to secure the proper temperature for distribution. The position of the mixing valves is automatically governed by outdoor control equipment and water temperature controls located in the discharge connection of each circulating pump.

The three heating water pumps are all of the double suction centrifugal type and are each capable of supplying 400 g.p.m. against a 50-ft. head. These pumps operate at constant speed, supplying a constant amount of water—the amount of heat supplied being changed by varying the water temperature. The capacity of two of these pumps is sufficient to meet the needs of the buildings under peak load conditions—the third pump is provided as a spare unit. The pumps are so arranged that one pump can carry the load in mild weather.

Distribution System

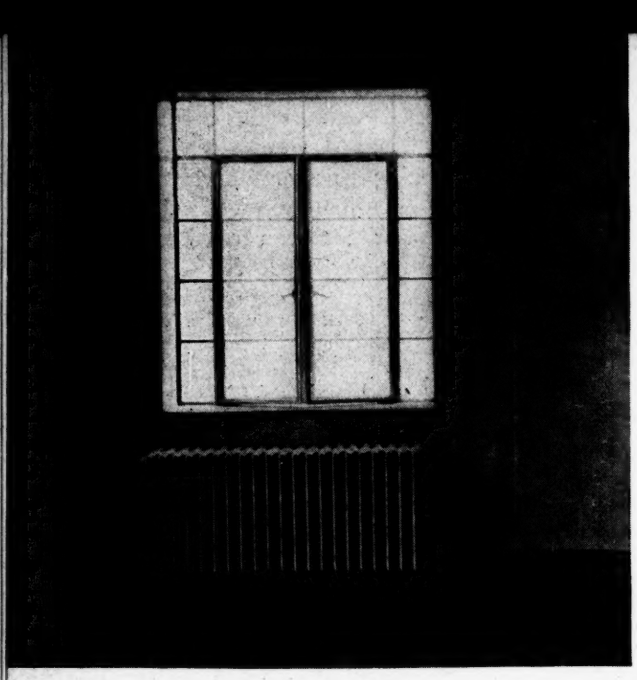
Hot water leaving the pump is carried by underground piping installed in conduits. Copper expansion joints located in suitable concrete chambers are provided to take up the expansion of the piping. The conduit which carries the heating pipe underneath Mediterranean Avenue is made of heavy cast iron to withstand vibration and weight caused by heavy city traffic and railway operation. All of the piping installed in conduits has been covered with a laminated asbestos felt insulation having an integral waterproof jacket.

Building Heating System

At the point where the heating supply piping enters each building there has been installed a pressure dif-

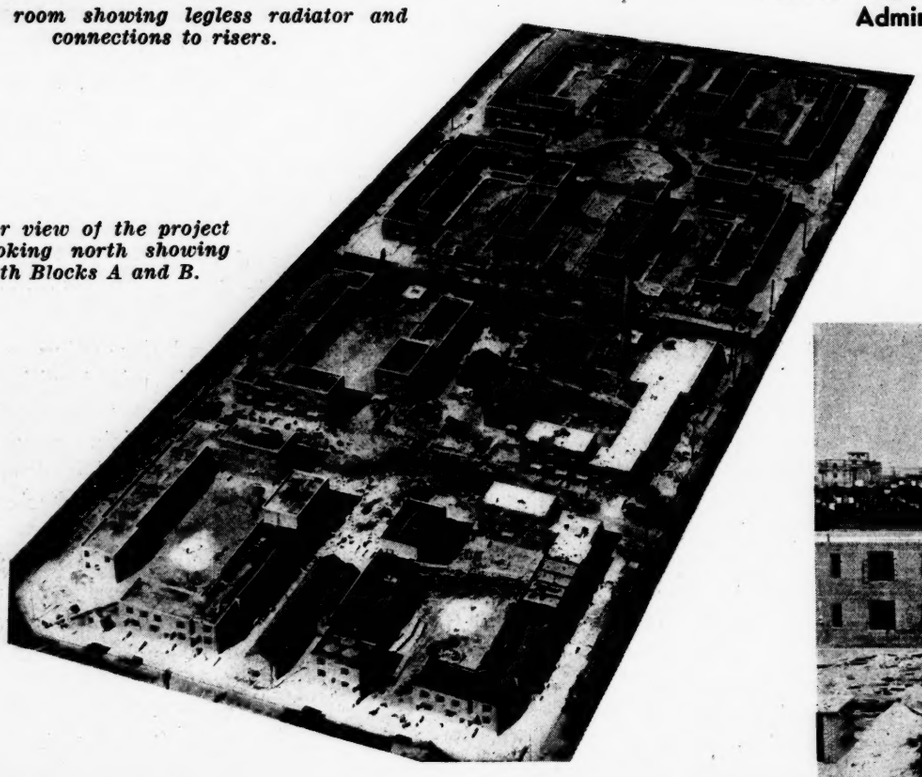
A LARGE LOW-RENT

The emphasis on low rent housing by both private builders and the Federal Government has resulted in the development of heating systems incorporating a number of new ideas and adaptations of conventional practices. The primary requisite of such heating systems is a low long time cost—that is, the best combination of low first, operating, and maintenance costs. An excellent example of such a system is the one incorporated in the Stanley S. Holmes Village in Atlantic City, N. J. This project which will provide comfortable and sanitary accommodations for 277 families is one of the 51 large low rent projects now under construction by the Housing Division of the Federal Emergency Administration of Public Works.

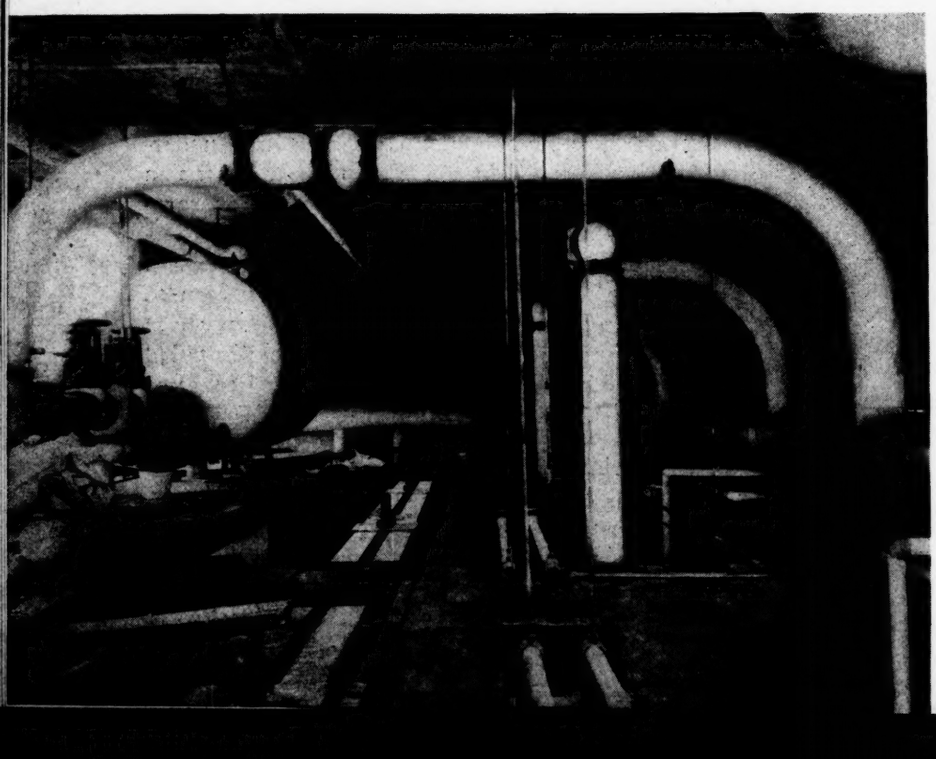


Typical room showing legless radiator and connections to risers.

Air view of the project looking north showing both Blocks A and B.



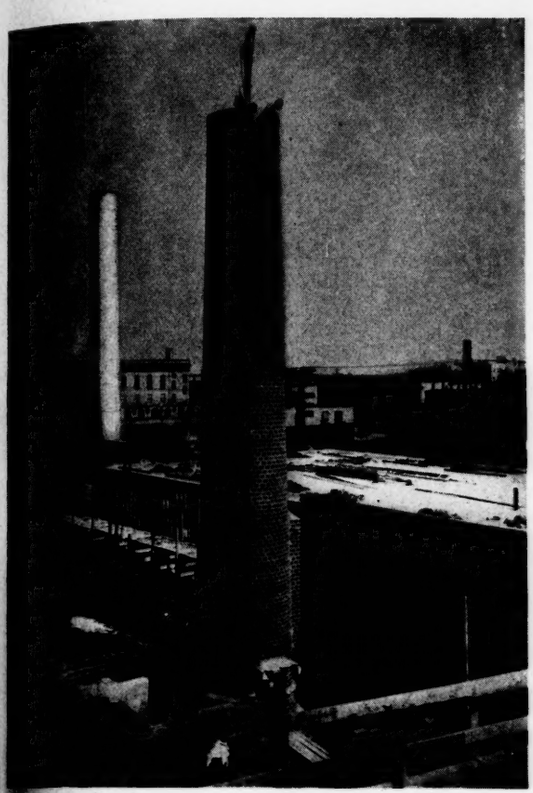
Looking southeast from third floor roof of buil B-6 showing steam piping conduit running betw buildings B-5 and B-8.



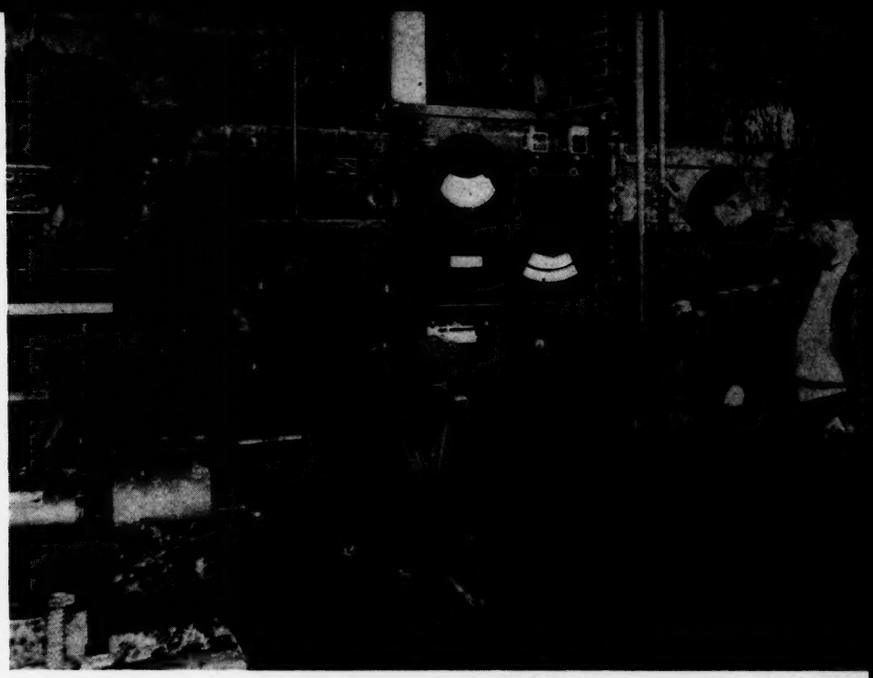
(Left) A piping and hot water generator with co ing completed, on balcony at rear of boilers in ing plant.

HOUSING DEVELOPMENT

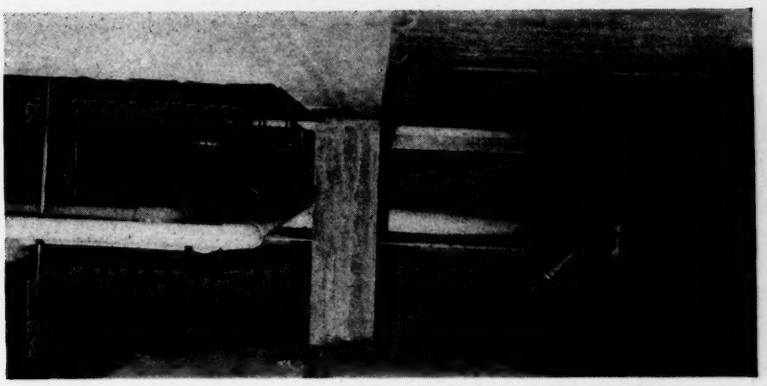
Heating Details



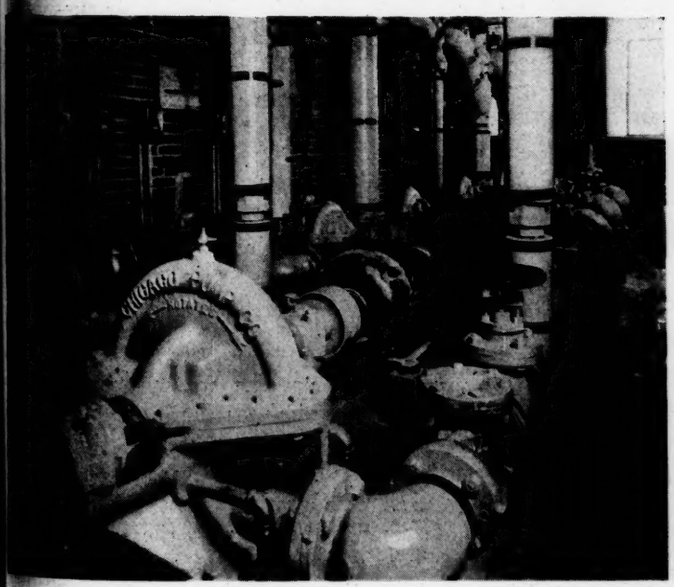
... looking northeast showing central heating plant and chimney.



Panel board of boiler No. 3 in heating plant. Mounted on the panel are a CO_2 recorder and draft gage.

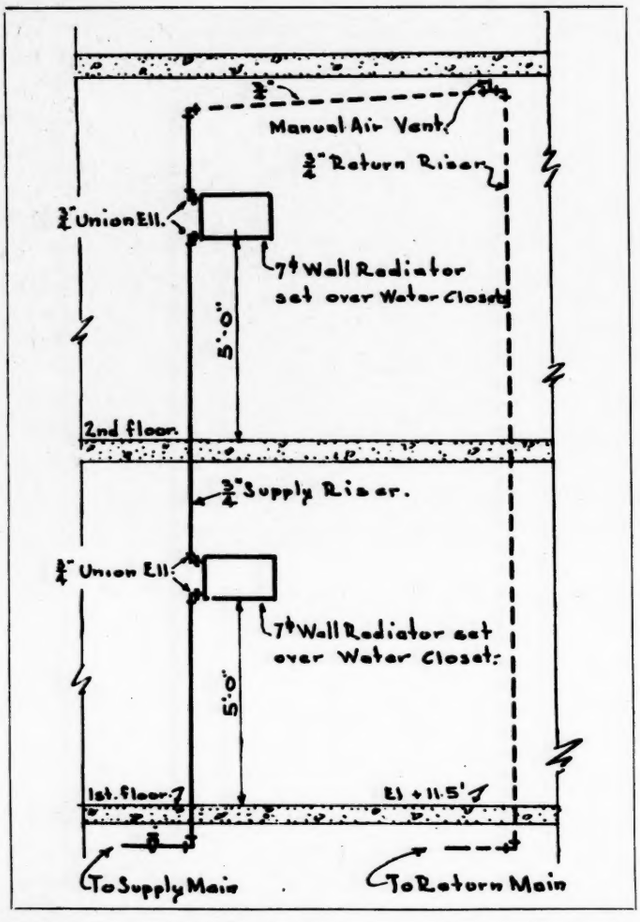


Piping under first floor of a typical building.



Pump room in the central heating plant.

(Below) Roof of coal and ash storage room showing the unloading of coal.



Method of connecting the bathroom radiators in the Atlantic City project. Note that the radiators are in series. The drawing is not to scale.

ferential control valve to maintain a constant pressure differential between the heating supply and return piping in that particular building. This valve makes possible the proper distribution of water to the various radiators at all times independent of pressure changes in the system. The valves can be adjusted to maintain any pressure differential from 1 lb. to 15 lb. per sq. in.

Supply and return mains in each building are run in spaces underneath the first floor and each main is furnished with suitable drains, a thermometer well, and a pressure gage. Three-quarter inch risers, set close to the walls, carry the water to the radiators. All radiators except those in bathrooms are of the legless narrow tube hot water type wall hung. Radiators for bathrooms are of the wall pattern type and are installed above the water closet approximately 5 ft. from the floor. Bathroom radiators are connected in series with the water entering at the lower part of the radiator and leaving the upper part. An overhead return on the top floor carries the water to a high point where there is a hand type air valve. The water is then carried back to the return mains beneath the first floor.

Each radiator supply valve has been equipped with a special type multiplate orifice resistance tube so that the supply of water to each radiator may be controlled. All of the return mains are carried back to the boiler plant through the conduit housing the supply mains. In the boiler plant the returns are connected to the mixing valves and to the return of the boiler.

Domestic Hot Water

All of the domestic hot water is heated and stored in the boiler plant by two generators located above the boilers. Each of these combined generator storage tanks is capable of heating 1500 gal. of water per hour from 40 to 165F and has a storage capacity of approximately 2040 gal. They are constructed of a steel shell with a sheet copper lining installed in such a manner that the domestic water does not come in contact with the steel shell. Each generator is provided with a 1-in. relief valve set to relieve at 75 lb.

Water at 230F is taken from the boiler mains by two hot water generator pumps and forced through the heating coils of the generator. These pumps are of the double inlet centrifugal type and each has a capacity of 300 g.p.m. against a head of 40 ft. There is located in the heating supply lines of each generator a temperature regulating valve. These valves are of such a type that they can be adjusted to provide any domestic water temperature between 140 and 180F. Returns from the generator are taken into the heating system return and thus back into the boiler. One storage tank and generator is provided for each block of buildings though they are cross-connected so that it is possible to obtain water from either generator.

The supply and return domestic hot water piping is installed in underground conduit of the vitrified tile type except where it crosses Mediterranean Avenue where it is encased in a cast iron conduit. Thermal expansion is taken care of by copper expansion joints enclosed in suitable concrete expansion chambers. The piping is insulated with laminated asbestos felt. The hot water piping on entering the building rises to the ceiling and is connected to the building piping system with a lock shield shut-off valve.

A small size return main is provided from each building to carry some of the domestic hot water back to the domestic hot water circulating pumps in the pump room and then to the cold water inlet of the hot water generators. Three pumps are used—two for actual service and one for reserve. Each is of the double suction, centrifugal type, having a capacity of 75 g.p.m. against an 80-ft. head. It is the purpose of these pumps and of the circulating system to keep a supply of hot water in the pipes at all times. A lock shield valve is provided on the return in each building for pressure balancing purposes. The domestic hot water piping in the furred spaces and plumbing chases is covered with ½-in. insulating covering. All other domestic hot water lines have a ¾-in. covering.

Controls

As mentioned previously a varying water temperature to the radiators is obtained through the medium of mixing valves which are automatically controlled by means of outdoor thermostats in accordance with the outdoor air temperature. The system is so designed that when the outside temperature is zero the mixing valve will supply water at a mean temperature of approximately 230F to the radiators. This high temperature has made it possible to use radiators which are no larger than those used on steam heating systems.

Boiler room showing the three horizontal tubular hot water boilers and bituminous stokers. An instrument panel is provided for each boiler.

The automatic temperature controls are continuously variable throughout the range of heating season temperatures. To compensate for unusual weather conditions the water temperature may be manually adjusted to provide higher or lower temperatures.

The temperature of the boilers is maintained constant at 230F by means of immersion temperature controls. These devices control the operation of the stoker. Each boiler is also provided with an additional immersion type temperature control which acts as a maximum limit control. Each stoker motor is also controlled by a pressure limiting control which is located in the expansion tank. There are three of these pressure controls on the expansion tank and each one will shut down its own stoker motor in case the expansion tank pressure drops below 20 lb. and will prevent the motor from operating until the pressure builds up beyond this.

Air Conditioned Bus Operating in the South

AN air conditioning unit for motor coaches, engineered and constructed by the Kelvinator Division of Nash-Kelvinator Corporation, has been built into a deluxe streamlined passenger bus. This coach is now making a three months' demonstration tour throughout the south.

Powered by a six-cylinder engine, designed primarily for long distance high speed trunk line operations, the research coach offers perfect riding comfort for passengers. Filtered, cooled, and dehumidified air is changed completely once every three minutes.

The coach is capable of sustained operation of greater than 600 miles per day, has an operating speed of 55 miles per hour, and travels 5½ miles on a gallon of gasoline. It accommodates 29 passengers and a driver.

The air conditioning system is the only one of its kind, with a unit designed exclusively for coach service.

Outside air enters at the front of the body and is conveyed to the air conditioning unit at the rear, where it is filtered, cooled, and dehumidified. It then passes into ducts built into the luggage racks directly above the seat and running the length of the coach on both sides. The air is forced downward from these compartments onto a mushroom horizontal deflector which circulates the cooling air in such a manner as to envelop the passengers indirectly, without the discomfort of cold air drafts.

Power for both the refrigerant compressor and the fan for air circulation is obtained through belt drive from a gasoline engine, which has been designated as the "power unit."

The power unit operates continuously at constant speed. The loading of this engine is fully constant and varies with the demand for cooling. When the bus comfort temperature is satisfied, the thermostat breaks the circuit to liquid solenoid valve. This stops circulation of the refrigerant to the cooling coil. Since the refrigerant compressor operates continuously, it eventually pumps all the refrigerant back through the air cooled condenser to the liquid refrigerant receiver.

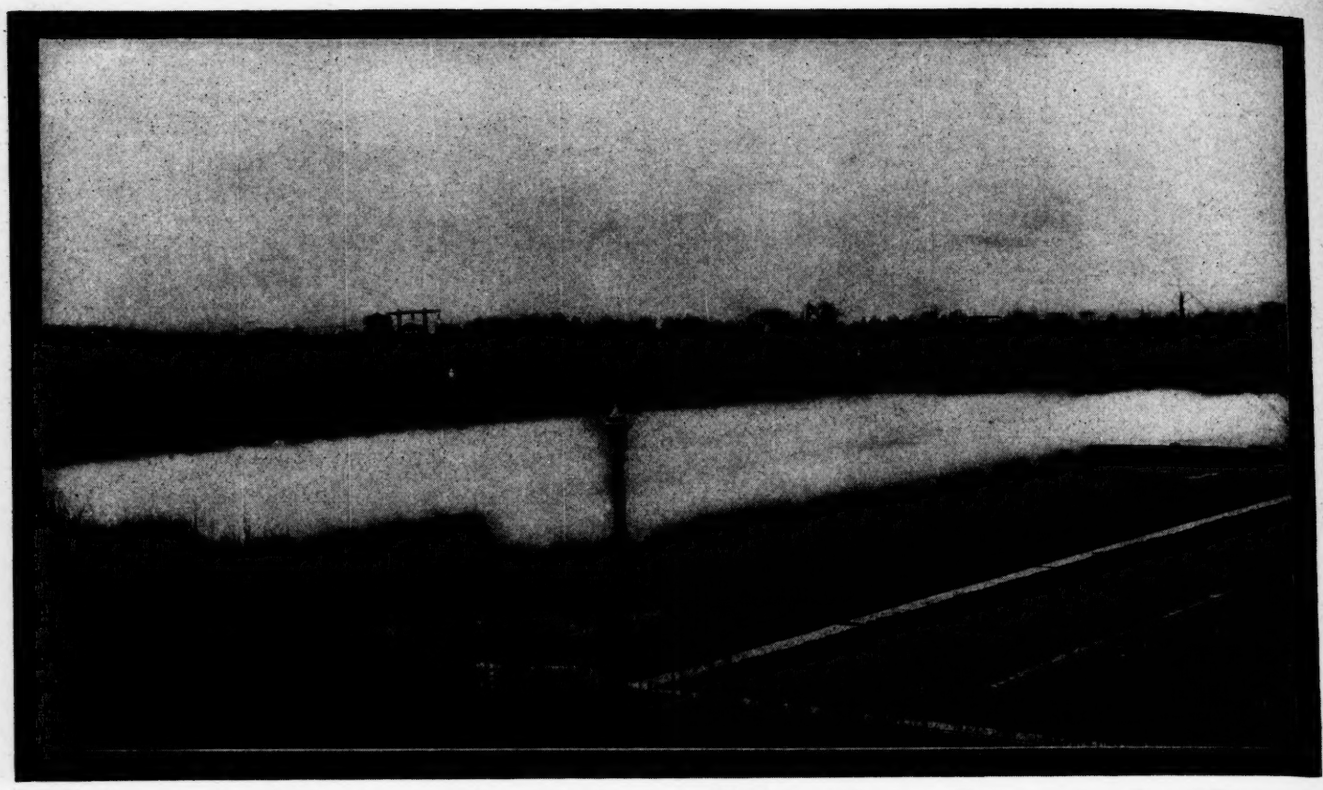
During this operation the suction pressure continues to drop and eventually reaches a stage where the low-pressure cut-out closes the circuit to the bypass solenoid valve. This opens the bypass circuit, equalizing the head and suction pressure on the compressor, and accordingly reduces the load on the engine to a minimum. During this off cycle, the gasoline engine continues to operate at reduced load until cooling is again called for. Then the cycle is automatically re-established.

In the event of excessive head pressure, the high pressure cut-out automatically opens, causing the liquid solenoid valve to close and the cycle continues identically as described under thermostatic control.

A hand switch in the circuit of the bypass solenoid valve is manually closed prior to starting of the power unit in order to unload the compressor while cranking the engine.

A second hand switch is provided for grounding the magneto when it is desired to stop the gasoline engine.

The Lord Kelvin, an air conditioned bus which is now making a demonstration tour throughout the South. See "Picture Paragraphs" for other views of this bus.



Spray ponds are a dependable means of cooling water for air conditioning condensers. Photos courtesy Yarnall-Waring Co.

Atmospheric Cooling Equipment for Condenser Water

By FRED D. MOSHER

SPRAY ponds have been found to be effective cooling devices for air conditioning systems of large capacity provided low rental space is available. While the first cost and maintenance costs are greater for spray ponds than for cooling ponds, the efficiency of spray ponds is higher. The temperature to which the water can be cooled depends upon the wet-bulb temperature of the surrounding atmosphere, hence it varies with the location of the pond.

To obtain the desired cooling in a spray pond installation, the incoming water is pumped through spray nozzles under pressure. These nozzles break up the water so that it comes into intimate contact with the air. Evaporation of some of the particles produces the cooling. Spray ponds may be located on the roofs of buildings or on the ground, but in either case they should be installed with the axis normal to the prevailing winds. The pond itself may be constructed in the same way an ordinary cooling pond is constructed but without the usual trough. The water in the case of the spray pond enters the pond through the nozzles, and as with the cooling pond, the suction is located at the lowest point. To prevent excessive water loss a louvered fence, from 8 to 12 ft. high, should be built around the pond.

The amount of water a spray pond can cool properly depends on, among other variables, the pressure on the nozzles, their size, number, and spacing. Pressures may range from 6 to 12 lb. per sq. in., while the capacities per nozzle usually range from 20 to 50 g.p.m. depending on the size of the pipe and the size of the orifice. Fig. 1 shows a sketch of a typical spray pond. Tables 1a and 1b give data on spray ponds with nozzle data.

Most spray ponds are designed for a wind velocity of 5 m.p.h. The temperatures to which a properly designed spray pond will cool water are shown in Table 2. This table gives the temperatures obtainable for various types of atmospheric cooling devices during the summer months throughout the United States. It has been found that air conditioning equipment requires 3 to 6 g.p.m. of condenser cooling water per ton of refrigerating capacity, and that the water loss from a spray pond is from 2 to 5% of the total circulation. Nozzles are usually set from 3 to 6 ft. above the surface of the pond in groups of 4 or 5, with a space of 12 ft. separating group centers. Scale formation and algae growth in spray ponds are usually heavy and the water should be treated accordingly.

Cooling Towers

Modern cooling towers fulfil all the requirements of large scale air conditioning. Cooling towers of large capacity can be located on the roofs of tall buildings

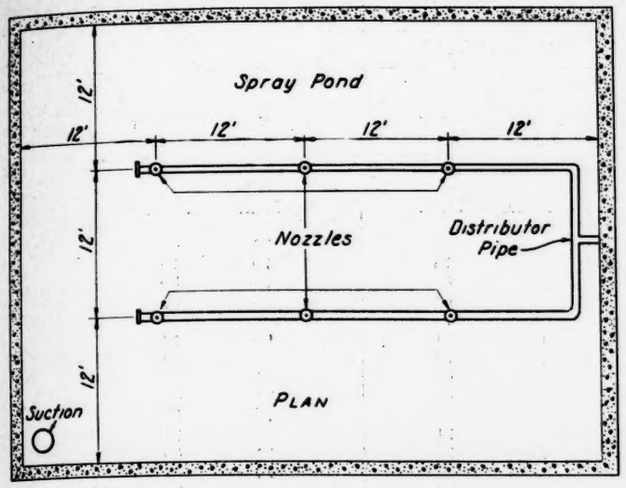


Fig. 1. Plan of a typical small spray pond. Suction pipe outlet is at lowest point in pond.

or other limited spaces. Numerous cooling tower installations have been made on the roofs of theaters, hotels, department stores, and office buildings throughout the country.

There are in general two types of cooling towers: naturally ventilated and mechanically ventilated.

Atmospheric Tower

The simplest of the naturally ventilated cooling towers is the atmospheric tower. This type of tower is made up of a shell or casing of wood or metal filled on the inside with a zig-zag structure of boards or laths and wind bracing. The warm water to be cooled flows in at the top, trickles down through the filling where it comes into contact with the cooling air, and is caught in a basin or pan at the bottom of the tower from which it flows to the condensers. Such towers are of heights and base areas depending on capacity and type. The shell of the tower may be of alloy metal such as copper bearing steel or wood covered by thin sheets of such metal. The filling is usually of cypress or redwood. The purpose of the filling is to break the water up into fine particles as it falls from the distributing troughs so that evaporating surface of the water is increased. Air flows in a transverse direction through the louvered sides of this type tower; the louvers also prevent the water from being blown out. If properly constructed and located where the natural wind can circulate freely through it, the atmospheric cooling tower may be used to advantage for moderate size installations. The first cost of the atmospheric type tower is low and the upkeep negligible. To be effective they must be narrow in cross section; hence for large installations they are very long. Since this type tower depends on the natural wind for air circulation, a knowledge of the direction of the prevailing wind is necessary when it is being planned so that the axis may be properly directed to take full advantage of the air currents.

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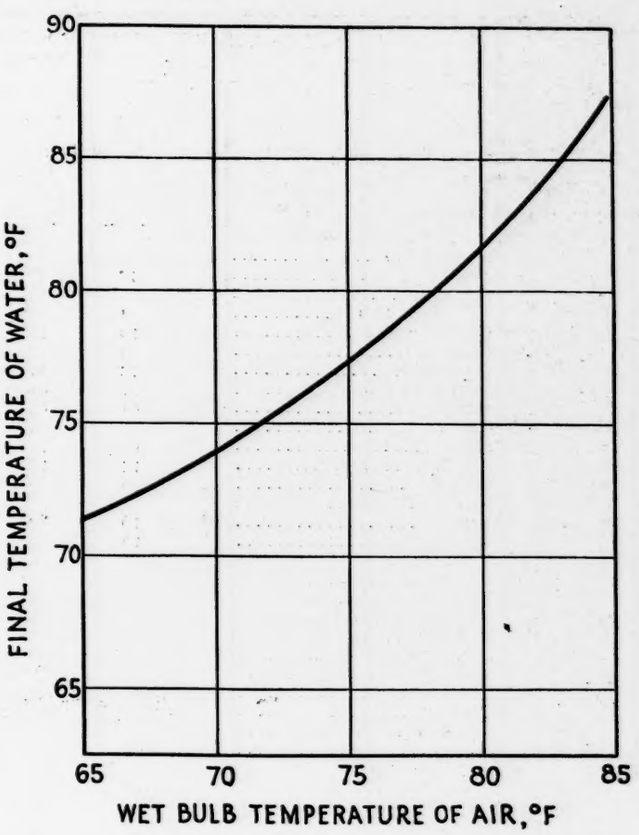

Fig. 2. Performance curve of a spray nozzle atmospheric cooling tower. Curve is for a 10F range.

nozzles are located in the center of the tower, the tower being about 20 ft. high. When the spray nozzles are used in this way the tower becomes a narrow spray

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(Based on data from 1934-36 ASRE Refrigerating Data Book)

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	Water Temperature Leaving Spray Pond, Deg. F.					
	5	10	15	5	10	15
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60....	64.0	68.0	70.5	66.5	71.0	75.5
65....	69.0	72.0	75.5	71.3	75.5	80.0
70....	73.5	77.0	79.5	75.8	80.0	84.0
75....	78.5	81.6	83.5	80.8	84.5	89.0
80....	83.0	85.5	88.0	85.5	89.0	93.0

TABLE 1B—REFRIGERATING CAPACITY OF SPRAY PONDS*

Pond Dimensions, Ft.	Required Groups of Nozzles, 5 in Group	Required Number of Nozzles, 12 Ft. Apart	Refrigerating Load, Tons
36 x 36	4	20	80
36 x 48	6	30	120
36 x 60	8	40	160
36 x 108	16	80	320
48 x 48	9	45	180
48 x 60	12	60	240
48 x 108	24	120	480

*The data in Table 1B are based on use of nozzles having a capacity of 20 g.p.m. each, set up in groups of 5 spaced 12 ft. apart and 12 ft. between centers; distributor pipe 2 in. diameter, and louvered fence 12 ft. high.

Spray ponds are a dependable means of cooling water for air conditioning condensers. Photos courtesy Yarnall-Waring Co.

Atmospheric Cooling Equipment for Condenser Water

By FRED D. MOSHER

SPRAY ponds have been found to be effective cooling devices for air conditioning systems of large capacity provided low rental space is available. While the first cost and maintenance costs are greater for spray ponds than for cooling ponds, the efficiency of spray ponds is higher. The temperature to which the water can be cooled depends upon the wet-bulb temperature of the surrounding atmosphere, hence it varies with the location of the pond.

To obtain the desired cooling in a spray pond installation, the incoming water is pumped through spray nozzles under pressure. These nozzles break up the water so that it comes into intimate contact with the air. Evaporation of some of the particles produces the cooling. Spray ponds may be located on the roofs of buildings or on the ground, but in either case they should be installed with the axis normal to the prevailing winds. The pond itself may be constructed in the same way an ordinary cooling pond is constructed but without the usual trough. The water in the case of the spray pond enters the pond through the nozzles, and as with the cooling pond, the suction is located at the lowest point. To prevent excessive water loss a louvered fence, from 8 to 12 ft. high, should be built around the pond.

The amount of water a spray pond can cool properly depends on, among other variables, the pressure on the nozzles, their size, number, and spacing. Pressures may range from 6 to 12 lb. per sq. in., while the capacities per nozzle usually range from 20 to 50 g.p.m. depending on the size of the pipe and the size of the orifice. Fig. 1 shows a sketch of a typical spray pond. Tables 1a and 1b give data on spray ponds with nozzle data.

Most spray ponds are designed for a wind velocity of 5 m.p.h. The temperatures to which a properly designed spray pond will cool water are shown in Table 2. This table gives the temperatures obtainable for various types of atmospheric cooling devices during the summer months throughout the United States. It has been found that air conditioning equipment requires 3 to 6 g.p.m. of condenser cooling water per ton of refrigerating capacity, and that the water loss from a spray pond is from 2 to 5% of the total circulation. Nozzles are usually set from 3 to 6 ft. above the surface of the pond in groups of 4 or 5, with a space of 12 ft. separating group centers. Scale formation and algae growth in spray ponds are usually heavy and the water should be treated accordingly.

Cooling Towers

Modern cooling towers fulfil all the requirements of large scale air conditioning. Cooling towers of large capacity can be located on the roofs of tall buildings

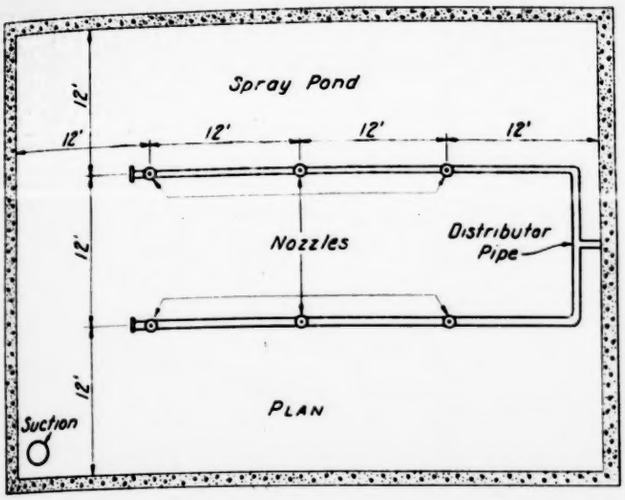

Fig. 1. Plan of a typical small spray pond. Suction pipe outlet is at lowest point in pond.

or other limited spaces. Numerous cooling tower installations have been made on the roofs of theaters, hotels, department stores, and office buildings throughout the country.

There are in general two types of cooling towers: naturally ventilated and mechanically ventilated.

Atmospheric Tower

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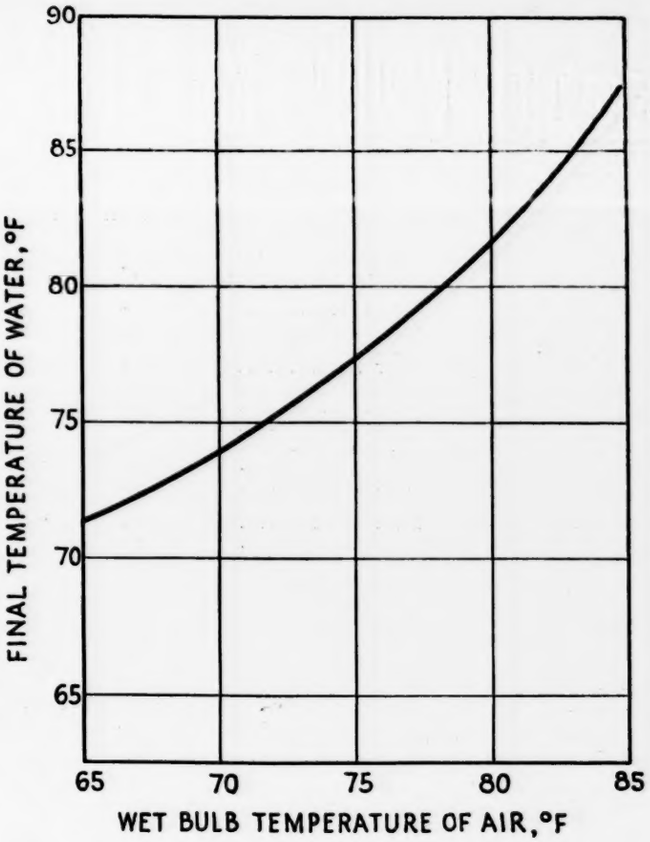

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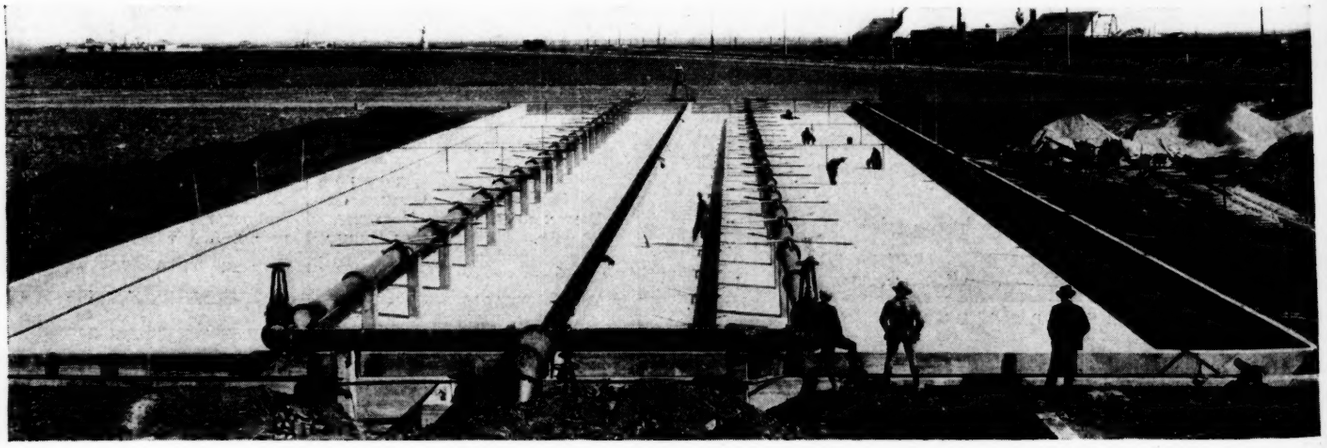
TABLE 2—TEMPERATURE OF WATER FROM ATMOSPHERIC COOLING EQUIPMENT DURING SUMMER MONTHS

State	Method of Cooling					
	Spray Ponds		Natural Draft Cooling Towers		Mechanical Draft Cooling Tower	
	Temperatures To Be Expected, °F					
	Min.	Max.	Min.	Max.	Min.	Max.
Alabama	81	85	80	84	79	87
Arizona	72	76	71	75	70	78
Arkansas	80	84	79	83	78	86
California (N)	61	65	60	64	59	67
California (S)	70	74	69	73	68	76
Colorado	68	72	67	71	66	74
Connecticut	73	77	72	76	71	79
District of Columbia	77	81	76	80	75	83
Florida	81	85	80	84	79	87
Georgia	80	84	79	83	78	86
Idaho	68	72	67	71	66	74
Illinois	74	78	73	77	72	80
Indiana	76	80	75	79	74	82
Iowa	74	78	73	77	72	80
Kansas	76	80	75	79	74	82
Kentucky	76	80	75	79	74	82
Louisiana	81	85	80	84	79	87
Maine	67	71	66	70	65	73
Maryland	76	70	75	69	74	82
Massachusetts	72	76	71	75	70	78
Michigan	70	72	69	71	68	76
Minnesota	70	72	69	71	68	76
Mississippi	81	85	80	84	79	87
Missouri	76	80	75	79	74	82
Montana	67	71	66	70	65	73
Nebraska	74	78	73	77	72	80
Nevada	65	69	64	68	63	71
New Hampshire	72	76	71	75	70	78
New Jersey	75	79	74	78	73	81
New Mexico	64	68	63	67	62	80
New York	72	76	71	75	70	78
North Carolina	79	83	78	82	77	85
North Dakota	70	74	69	73	68	76
Ohio	74	78	73	77	72	80
Oklahoma	77	81	76	80	75	83
Oregon	67	71	66	70	65	73
Pennsylvania	74	78	73	77	72	80
Rhode Island	72	76	71	75	70	78
South Carolina	80	84	79	83	78	86
South Dakota	70	74	69	73	68	76
Tennessee	79	83	78	82	77	85
Texas	77	81	76	80	75	83
Utah	65	69	64	68	63	68
Vermont	70	74	69	73	68	76
Virginia	78	82	77	81	76	84
Washington	64	68	63	67	62	70
West Virginia	75	79	74	78	73	81
Wisconsin	72	76	71	75	70	78
Wyoming	67	71	66	70	65	73

pond with higher efficiency because of the larger cooling area offered by the filling and louvers. A curve showing the performance of an atmospheric cooling tower using spray nozzles is given in Fig. 2.

Chimney Draft Tower

There are times when it is found that an atmospheric cooling tower fills the requirements as to load but adequate space is not available; it is in cases of this kind



Construction details of a spray pond. Note arrangement of nozzles.

that the natural or chimney draft tower finds its application. This type of tower gets its name from its chimney-like structure and from the fact that the air circulates through the tower due to the "chimney effect." For the same cooling capacity the natural draft tower occupies about half the base area of the atmospheric tower. For the first 10 ft., beginning at the base, the natural draft tower is louvered for the admission of air. From the top of the louvers to the top of the tower the sides are closed. The water is discharged, as in the atmospheric tower about 30 ft. above the base, the tower being extended like a chimney about 60 ft. above the water discharge. The denser air on the outside produces the velocity required on the inside. For high temperature incoming water these natural draft towers are effective since the velocity of the air reaches about 300 f.p.m. The natural draft tower has the advantage of being, to a large extent, independent of the natural wind currents. Its first cost, of course, is higher than that of the atmospheric tower.

Spray-filled Tower

For small air conditioning installations the spray-filled cooling tower has been found to be efficient and economical. The spray-filled tower gets its name from

TABLE 3—SUMMER WIND VELOCITIES AND PREVAILING DIRECTION, JUNE TO SEPTEMBER, INCL.

State	City	Average Wind Velocity, Miles per Hour	Prevailing Wind Direction
Alabama	Birmingham	5.2	S.
	Mobile	8.6	S.W.
Arizona	Phoenix	6.0	W.
Arkansas	Little Rock	7.0	N.E.
California	Los Angeles	6.0	S.W.
	San Francisco	11.0	S.W.
Colorado	Denver	6.8	S.
Connecticut	New Haven	7.3	S.
District of Columbia	Washington	6.2	S.
Florida	Jacksonville	8.7	S.W.
	Tampa	7.0	E.
Georgia	Atlanta	7.3	N.W.
	Savannah	7.8	S.W.
Idaho	Boise	5.8	N.W.
Illinois	Chicago	10.2	N.E.
	Peoria	8.2	S.
Indiana	Indianapolis	9.0	S.W.
Iowa	Des Moines	6.6	S.W.
Kentucky	Louisville	8.0	S.W.
Louisiana	New Orleans	7.0	S.W.
Maine	Portland	7.3	S.
Maryland	Baltimore	6.9	S.W.
Massachusetts	Boston	9.2	S.W.
Michigan	Detroit	10.3	S.W.
Minnesota	Minneapolis	8.4	S.E.
Mississippi	Vicksburg	6.2	S.W.
Missouri	Kansas City	9.5	S.
	St. Louis	9.4	S.W.
Montana	Helena	7.3	S.W.
Nebraska	Lincoln	9.3	S.
Nevada	Reno	7.4	W.
New Jersey	Trenton	10.0	S.W.
New York	Albany	7.1	S.
	Buffalo	12.2	S.W.
	New York	12.9	S.W.
New Mexico	Santa Fe	6.5	S.E.
North Carolina	Asheville	5.6	S.E.
	Wilmington	7.8	S.W.
North Dakota	Bismarck	8.8	N.W.
Ohio	Cleveland	9.9	S.
	Cincinnati	6.6	S.W.
Oklahoma	Oklahoma City	10.1	S.
Oregon	Portland	6.6	N.W.
Pennsylvania	Philadelphia	9.7	S.W.
	Pittsburgh	9.0	N.W.
Rhode Island	Providence	10.0	N.W.
South Carolina	Charleston	9.9	S.W.
	Greenville	6.8	N.E.
Tennessee	Chattanooga	6.5	S.W.
	Memphis	7.5	S.W.
Texas	Dallas	9.4	S.
	Galveston	9.7	S.
	San Antonio	7.4	S.E.
	Houston	7.7	S.
	El Paso	6.9	E.
Utah	Salt Lake City	8.2	S.E.
Vermont	Burlington	8.9	S.
Virginia	Norfolk	10.9	S.
	Richmond	6.2	S.W.
Washington	Seattle	7.9	S.
	Spokane	6.5	S.W.
West Virginia	Parkersburg	5.3	S.E.
Wisconsin	Madison	8.1	S.W.
	Milwaukee	10.4	S.
Wyoming	Cheyenne	9.2	S.

the construction of the tower. The shell or casing of the tower is of the conventional box shape with air inlet louvers around the lower part extending to the base of the tower. Instead of being filled with wood the tower is furnished with spray nozzles set about midway in the tower discharging the water upwards in a fan-like spray. These towers must be properly proportioned with the height usually equal to the width. The shell is made of alloy steel or corrosion-resisting wood with appropriate wind bracing for stability of the structure. The economic limit of this type tower is between 100 and 200 tons refrigerating capacity; for higher tonnage other types of towers are more suitable.

Before any decision is made as to the type of tower to be used, a study of local atmospheric conditions should be made by someone familiar with such work. The designing and locating of cooling towers is the work of specialists who are acquainted with the factors to be considered. Towers are not designed on the "tonnage" of refrigeration used but on the B.t.u. heat exchange involved and are guaranteed to deliver water within 4 to 8F of a specified wet bulb temperature. The losses due to evaporation and "drift" can usually be closely approximated. The loss is about 4% of the total circulation for atmospheric towers and around 3% for the natural draft tower. Temperatures to be expected from various kinds of atmospheric cooling devices are included in Table 2. The directions and velocities of the prevailing winds as compiled by the U. S. Weather Bureau for the summer months for the important cities throughout the United States are given in Table 3.

De-Dusting Coal

THE practice of spraying fuels with various liquids to reduce dustiness is becoming increasingly popular. Spraying equipment is being installed at many mines and preparation plants and also in retail coal yards.

Some of the characteristics an ideal treating agent should have are: effectiveness for the period of time desired, low cost per ton of fuel effectively treated, no harmful effects on person, clothing, or equipment, lack of odor in the consumer's bin, no danger of flash-back or rapid evolution of obnoxious gases on firing, freedom from the possibility of freezing in spraying equipment, no increase in the tendency for fuels to cake or lump in freezing weather, no deleterious effect on the combustion characteristics of the fuel or on the fusion point of the ash and no deleterious effect on the storing qualities of coal.

Calcium Chloride Sprays

Calcium chloride solution is commonly used for dustproofing fuel. Measurements of the ash-fusion temperatures of treated and untreated fuels indicated that the addition of calcium chloride tended to decrease the fusion temperature of the ash when this temperature was high and to increase the fusion temperature when it was low. No appreciable effect of treatment on burning or clinkering properties were observed in standard house-heating furnaces.

One disadvantage in the use of calcium chloride is its tendency to corrode metal parts with which it comes in contact. This is especially noticeable in metal work near the sprays and in railroad cars and chutes with which the treated coal comes in contact.

In the vicinity of the calcium chloride sprays difficulties with electric circuits often arise. These circuits must be protected from the action of the spray. Care must be taken to minimize the amount of solution deposited elsewhere than on the fuel to be treated.

Miscellaneous Spraying Compounds

Blackstrap molasses in water solution has been suggested, but no information is available as to its cost per ton of fuel effectively treated. A byproduct of glycerine manufacture containing salt and soda ash has been suggested. Its cost of dustproofing purposes is reported to be high. Petroleum sulphonic acid compounds in water solution have been used, but little information as to costs is available.

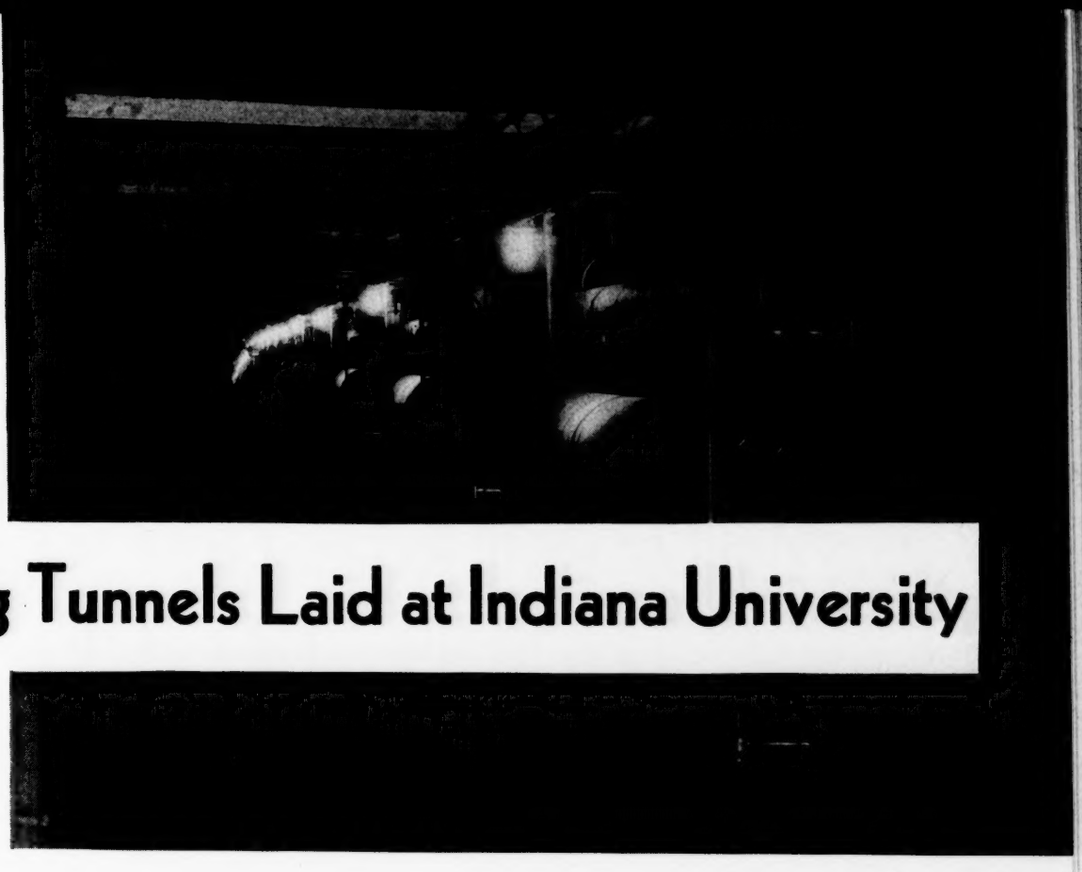
Oil Sprays

The use of oil for treating fuels to decrease dustiness is growing rapidly. Oil is applied to coal or coke by spraying from pressure nozzles as the coal is moving on a conveyor or, preferably, as it tumbles on leaving a conveyor or chute. Good distribution of the oil in a thin film over the surface of the coal particles is essential. Although oil itself is combustible and adds to the heating value of the fuel, excessive amounts must be avoided.

The oil should not give an objectionable odor when the coal is stored in the domestic bin, and it should be clean and well-filtered so as not to plug the filters or spray nozzles.

In general, the lower-viscosity oils are easier to handle and apply evenly on the fuel, while the higher-viscosity oils are more permanently effective. When oil-treated coal is charged on a hot fire the oil tends to vaporize, and there is danger of an immediate flash-back upon firing.

Too much oil or uneven distribution of the oil on the fuel defeats the purpose of greater cleanliness because of drainage of oil from the fuel. Oil can be applied to the fuel cold, or in the form of an emulsion in water. The cost of oil treatment of fuel has been given at 4 to 20 cents per ton of fuel treated.



New Heating Tunnels Laid at Indiana University

By TELFORD R. DAVIS†

DURING the fall of 1935, Indiana University, located at Bloomington, Indiana, in the heart of the famous limestone district, embarked upon an extensive building program with the aid of the Public Works Administration.

Indiana University up to 1935 had rapidly outgrown her classroom capacity, and hampered by lack of a regular tax levy for public and state institutional buildings, the situation became acute. The program of the Public Works Administration offered, therefore, a way out.

The first contemplated building on the campus was the Administration Building. This building was to be built at the extreme west side of the campus, rather remote from the central University power plant or existing steam or power lines. All old University buildings between the proposed site of the Administration Building and the power plant were served by a system of underground concrete tunnels that, like "Topsy," had just grown up. This old tunnel system jogged back and forth from building to building. It was crammed full of very old pipe, some in use and some ready for the junk pile. This old system represented over thirty years of useful but inefficient service.

With the addition of more heating load on the steam lines serving the buildings to the west, it was decided that the time had come to abandon the old narrow tunnel and aged piping and build a new tunnel and install new steam and return lines of sufficient capacity for all buildings to be served in this direction for the present, and contemplated for the future. The accompanying plot plan shows the old tunnel and the new.

The entry to the new tunnel is located in the basement of the University power plant. A new 16-in. steel low pressure steam main is carried into the tunnel at this point and reduces in size as it distributes to the various buildings along the route. A new 6-in. medium pressure main was installed, along with a vacuum return line. A new primary cable feeding the transformers for lights and power at the new Administration Building was suspended from the supporting channels across the top of the tunnel.

The length of the new tunnel is approximately 1300 ft., part of which was blasted out of solid limestone. Its construction required over 1461 yd of concrete, 6700 cu. yd. of earth excavation, and 2030 yd. of stone removal. The stone, with the exception of some small amounts, was dynamited. This was done in steps by drilling four or five charge holes across the excavation and covering the area with several layers of heavy wood planks before detonating the charge. For many days the campus looked like a shell-torn battle field, including all the sound effects.

After the installation of all the various pipe lines, a welded job, all covering and supports were painted with aluminum paint. The tunnel presents a very pretty picture indeed to the engineer who appreciates a job well done.

The costs of the various divisions of the work were as follows: For the construction of the concrete tunnel, $44,359; for steam and return piping, $19,975; for tunnel lighting and various feeder change-overs including a new primary to the Administration Building, $6,482.

The new tunnel system supplies only the seven buildings to the west of the power plant as indicated by the partial plot plan. There are, however, over a score of buildings on the campus, part of which are serviced by present tunnel systems and part by underground conduit systems. High pressure steam only is used in the conduit systems. New buildings built on the campus since 1935 are, besides the aforementioned Administra-

†Office of C. R. Ammerman, Consulting Engineer, Indianapolis, Ind.

Tunnel under construction in front of Administration Building shows type of excavation required.

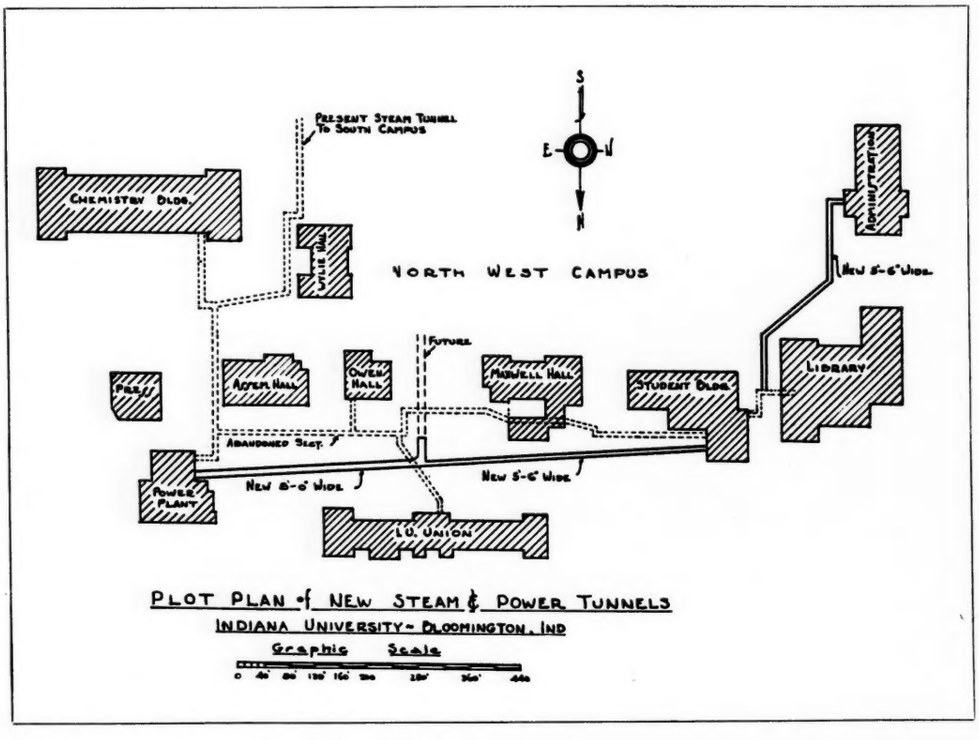
Completed tunnel structure in front of the Library at Indiana University.

tion Building, the new Women's Dormitory, a new School of Music, a new Medical School, and at the present writing a new Educational Building is under construction.

Such a building program as this of course meant expansion in the power plant. There was installed therein, previous to 1935, two 750-kw. non-condensing turbines and one standby 300-kw. steam engine generator, a relic of the old d.c. days. The generator on this engine had some years back been replaced with an a.c. machine. The new light and power loadings due to increased buildings required the addition of an additional generator. This was provided in the form of a 1500-kw. non-condensing extraction turbine generator. Extraction is made to a medium pressure header at between 50 to 35 lb. This header serves the medium pressure steam supply and, as a make up through pressure reducing valves to a low pressure header of 5 lb. supplying low pressure heating mains. The low pressure header receives the exhaust from the second stage of the extraction turbine and the back pressure of the other turbines and engine which exhaust at 5 lb. In the photograph of the turbine room the two 750-kw. generators are shown in the background, while the new 1500-kw. generator is in the foreground.

A new 675-hp. (normal rating) water tube boiler was installed during 1936 to supply additional steam requirements for light and power. The boiler room now contains a battery of four boilers. Fifth vein Indiana coal is used, supplied to the boilers on chain-grate stokers.

Truly Indiana University emerges from the depression with greatly increased facilities for higher education and future expansion.



New tunnel replaces older, abandoned heating lines in section shown in heavy lines in accompanying plot plan.

Design and Operation of Exhaust Ventilation Systems

For some time a committee of the American Standards Association has been at work on the whole general question of industrial exhaust ventilation. The subject is so broad that it has been necessary to consider it in parts. The present code, entitled "Fundamentals Relating to The Design and Operation of Exhaust Systems," is published by the Association with the hope that it will be studied and its principles applied in a critical analysis of existing exhaust systems which must be made in order that the committee may have a body of technical experience to form the basis of its future reports. The Association will welcome comments and criticisms from everyone.

LOCAL exhaust ventilation is employed extensively in industry for the removal, at the point of generation, of toxic, explosive or otherwise harmful concentrations of dusts, fumes, mists, vapors and gases. Industrial processes differ markedly, however, in their characteristics with respect to the application of exhaust ventilation and it is not possible to prepare one set of specifications and regulations which will suffice for the successful design and operation of every exhaust system. Each process constitutes an independent problem; there are, however, certain fundamental requirements common to all exhaust systems which should serve as the basis of design in every case. It was the object of the Sub-Committee on Fundamentals of the ASA Exhaust Code Committee to prepare an outline of these basic specifications.

It has not been general practice in the past to test new exhaust systems to determine the degree of control effected nor have such systems been described in terms of basic engineering specifications. Since most of the existing state codes require only the development of a definite amount of static suction, it has been enough simply to check this value. The considerable experience gained in the design of exhaust systems has not been evaluated and systematized and made generally available therefore to designing engineers. Personal experience still remains the principal guide to design.

In the present report an attempt is made to assemble in ordered fashion the fundamental concepts and data available at this time and to indicate the manner in which these influence the method of design. It is to be emphasized, however, that this report is incomplete and that a great deal of systematic and critical analysis of existing systems is necessary in order to build up a body of technical experience to serve as a guide for future design.

I. Definitions

101 DUSTS: Solid particles generated by handling, crushing, grinding, rapid impact, detonation and decrepitation of organic or inorganic materials such as rock, ore, metal, coal, wood, grain, etc. Dusts do not tend to flocculate except under electrostatic forces; they do not diffuse in air but settle under the influence of gravity.

102 FUMES: Solid particles generated by condensation from the gaseous state, generally after volatilization from molten metals, etc., and often accompanied by a chemical reaction such as oxidation. Fumes flocculate and sometimes coalesce.

103 MISTS: Suspended liquid droplets generated by condensation from the gaseous to the liquid state or by breaking up a liquid into a dispersed state, such as by splashing, foaming, and atomizing.

104 VAPORS: The gaseous form of substances which are normally in the solid or liquid state and which can be changed to these states either by increasing the pressure or decreasing the temperature alone. Vapors diffuse.

105 GASES: Normally formless fluids which occupy the space of enclosure and which can be changed to the liquid or solid state only by the combined effect of increased pressure and decreased temperature. Gases diffuse.

106 APPROVED: This term means approved by the proper administrative authority.

II. Plant Layout, Building Construction

201 Hazardous operations shall be segregated so far as is practicable, from non-hazardous work. (NOTE: In certain industries in which most of the processes produce harmful concentrations of polluting material, it is best to isolate the safe operations in a separate building or room.)

202 Hazardous operations shall be housed in buildings suitably adapted to the purpose.

(a) Buildings in which explosive dusts are handled shall conform to the requirements of the ASA Codes for the Prevention of Dust Explosions.

(b) Generators, tanks and other equipment in which toxic and explosive gases and volatile liquids are handled should not be housed in cellars or pits. Enclosed structures require, in addition to adequate ventilation for normal operation, means for generous ventilation in emergencies, such as quick-opening doors and windows. It is sometimes preferable to locate equipment in the open or cover only with a roof. Tanks containing different gases or liquids which combine to produce dangerous compounds shall be safely separated.

(c) The air supplied to protective hose masks shall be drawn from a point reasonably free from danger of contamination; a suitable air purifier is sometimes required. The air supply pipe should not be under negative pressure at any point within the building or other space in which the mask is used.

203 Lighting by natural and artificial means shall be adequate and properly distributed according to standard requirements. Light-colored paint on walls and ceilings is recommended, especially in corners and other dark places.

204 Walls and floors shall be constructed of materials which permit easy and efficient cleaning. In dusty plants horizontal surfaces and ledges on which dust may collect shall be kept at a minimum. Oiling or wetting down floors and walls are useful measures in certain plants for preventing the dispersion of settled dust. Frequent washing of floors for removing spilled materials is recommended for certain chemical plants; in these plants floors should be provided with adequate drainage facilities.

205 Good housekeeping shall be maintained at all times; in dusty plants it is desirable to eliminate as much as possible storage of materials upon which dust may collect. Accumulations of dust upon rafters and other horizontal surfaces should be removed periodically; vacuum-cleaning equipment is recommended for this purpose.

206 (a) Processes to be connected to one exhaust system should be located close together and arranged symmetrically about a center; purpose: (1) to permit the use of the shortest lengths of pipe and least number of bends, and (2) to insure proper proportioning of air flow from the various hoods.

(b) Processes generating different kinds of dusts, fumes or vapors must never be connected to the same exhaust system when the mixture results in the formation of toxic, inflammable or explosive compounds.

(c) It is undesirable to connect to the same exhaust system processes whose requirements, with respect to the velocities required for the transportation of the different materials collected, differ widely or where there is a wide difference in the initial resistance of the pieces of equipment being exhausted. If such combinations must be made, the higher velocities and static suction values should control the selection of fan and motor, and determine pipe sizes.

207 Equipment to be connected to one exhaust system should be arranged to permit the locating of exhaust piping so as: (a) not to interfere with the operation of cranes, elevators, trucks, etc., (b) to allow ready accessibility to the piping for inspection, cleaning and repairs, (c) to provide maximum protection of the piping against damage from outside, (d) to prevent condensation of moisture, etc., within the pipes.

208 When it is necessary to carry exhaust piping through fire walls automatic dampers as recommended by the National Fire Protection Association shall be provided in the exhaust duct (see American Standard Z33-1935). In certain industries similar restrictions are applicable to the passage of pipe through floors.

209 Scattered processes and equipment which is operated only infrequently are often protected most economically by means of separate exhaust apparatus connected to each machine. Such individual equipment shall conform in every essential respect to the requirements of this report which apply to multiple exhaust systems. A portable collector unit is sometimes used which may be moved from one machine to another as the operating schedule requires. Storage tanks, etc., which may contain dangerous dusts, fumes, vapors or gases should be adequately ventilated before entering; portable exhaust fan units are employed for this purpose.

210 Air-cleaning equipment should be located so as to permit the removal of dust or other collected material from the apparatus without creating a hazard and to allow for cleaning and repairing the apparatus without recontaminating the general plant air. (NOTE: Workers engaged in cleaning or repairing air-cleaning equipment shall be protected by means of approved respirators, air masks or gas masks. For specifications, see Safety Code for Protection of Heads, Eyes and Respiratory Organs of Industrial Workers—X2-1922, approved by the American Standards Association.)

211 Provision must be made for the entrance of *clean* air into the room or building to replace that removed by the exhaust system. Three conditions must be maintained: (1) Inlets shall be so arranged and located that the workers are not subjected to drafts of air having a temperature more than 10F below the general room temperature. Permissible inlet velocities are:

120 f.p.m. for inlets less than	8 ft. above floor;
250 f.p.m. for inlets	8-12 ft. above floor;
500 f.p.m. for inlets	12-18 ft. above floor;
1000 f.p.m. for inlets greater than	18 ft. above floor;

(2) In any room the static pressure must not be lower than in an adjoining room from which contaminated air may flow; (3) Inlet velocities must not be high enough to cause undesirable air motion near hooded processes and the influence of outside wind pressure must not be great enough to disturb the orderly flow of air into the building and out through the exhaust system.

III. Exhaust Hoods

A—DISPERSION OF ATMOSPHERIC IMPURITIES

301 Distinction should be drawn between the *production* of dusts, fumes, mists, vapors and gases and their *dispersion* into the atmosphere. Such substances are often produced without contamination of the atmosphere; on the other hand, dusts and fumes are frequently dispersed from areas where they were not produced. Example: Foundry sand, when placed in a mold, contains dust; more dust is produced by heat-fracture of the sand, burning out of clays and binders, residual ash from sea coal, etc. In the process of shaking out, this dust is liberated. The shaking out does not *make* dust.

302 The dispersion of contaminating material into the atmosphere requires energy, which is supplied in the following ways:

(1) SOLID AND LIQUID PARTICLES

(a) If they are large enough and are thrown off with sufficient velocity, they will be dispersed by the kinetic energy of their own motion, i.e., by dynamic projection. The energy supplied in this way varies with the size and specific gravity and the initial velocity of the particles.

(b) Microscopic particles can be dispersed but little distance by virtue of their own kinetic energy because of the relatively great resistance to the movement of small bodies through the air.

(c) Microscopic particles are dispersed *primarily* by the movement of the air in which they are suspended.

(2) VAPORS AND GASES

(a) The maximum velocity of diffusion does not exceed 1 f.p.m. and is therefore an unimportant dispersing force.

(b) Vapors and gases lighter or heavier than air rise or fall from their source but the velocity of escape is not high unless there is a considerable difference in density. Heavy gases may collect in pools or pockets of high concentration unless particular attention is paid to the question of air stagnation. A vapor or gas normally heavier than air may escape at a high temperature so that its density is reduced below that of air, thus causing it to rise; example: automobile exhaust gas.

(c) Vapors and gases escaping into the atmosphere at approximately the same density as the room air are dispersed primarily by air movement.

303 In order to prevent the dispersion of atmospheric impurities it is necessary to eliminate or otherwise control the energy of dispersion—which means, in most cases, the control of air motion. *The primary purpose of the exhaust hood, therefore, is to confine and exhaust contaminated air rather than to remove the contaminating material from the air.* This concept is important because it directs attention at once to the primary point of attack, namely, the source of air motion.

B—CONTROL OF AIR MOTION

The problem is two-fold: First, eliminate or reduce the velocity of air currents, wherever possible, around hazardous processes: by eliminating or otherwise controlling the sources of air motion; second, air motion which cannot be eliminated must be brought under control, i.e., the direction of motion must be changed so that all air flow is into the exhaust system.

305 Sources of air motion around industrial processes and operations may be classified into four major groups: (a) Motion or energy fundamental to the machine or process itself. Examples: fan-action of a rotating wheel, escape of air from containers as they are filled, convection currents and air expansion over heated surfaces such as molten metal, etc., vibration of screens. (b) Forces incidental to the operation of the machine or process. Examples: air escaping past worn pistons in pneumatic tools or from badly placed exhaust ports, vibration of machinery. (c) Drag of air by large particles dynamically projected from their source. Example: the drag of the stream of sparks thrown off tangentially from a grinding wheel creates an air current in the same direction which, in turn, disperses fine dust. (d) External forces. Examples: air motion created by the operation of nearby machinery, natural convection currents created by temperature changes and unequal wind pressures, air motion created by the high-velocity entrance of air into the room to replace that removed by the exhaust system (see Item 211).

306 Before the actual design of an exhaust hood is completed it is essential to determine the nature, magnitude, and direction of action of dispersing air currents and to eliminate these in so far as possible by simple direct means, such as:

(a) Slight alteration in the design or operation of the process. Examples: changing location of exhaust port on pneumatic tools, prohibiting the use of an air blast to blow dust off castings or equipment in a foundry.

(b) Remove external sources of air motion or shield hazardous processes from them. Example: enclose nearby belts, elevators, etc.; control natural convection currents.

(c) Prevent the machine or process itself from creating undesirable air motion, by the application of suitable baffles and housings. Such enclosures should be designed to serve one of two purposes: (1) to utilize the motion of the machine to produce air currents toward the exhaust hood or (2) to prevent the development of air motion by the machine. Examples: utilizing the fan-action of a grinding wheel for the collection of its own dust; enclosing a reciprocating tool as closely as possible to reduce the pulsating air currents away from the tool; providing a suitable vent for the safe escape of air from mixers, bags, bins or other containers as they are filled with powdered material or volatile liquids.

(d) Cause large particles, which are dynamically projected along a well-defined path, to travel directly into an exhaust hood. If this is not possible, provide baffles against which the large particles will impinge, thus destroying their motion and with it the air drag which causes the dispersion of minute particles.

(e) Eliminate the vibration of machinery by means of suitable foundations, proper machine design, etc.

(f) It is impossible to eliminate all air motion by these direct means alone but such measures are of great practical value in reducing the required size and capacity of the exhaust system and the cost of operation.

C—Hood Design

307 Object: To capture the contaminated air by means of air flow established toward and within the hood and to deliver this into the exhaust piping. Two basic factors are: the air velocities created in the zone of hood influence and the volume of air, Q, flowing into the hood per minute.† The air velocity toward the hood must be great enough to counteract the outward velocity of contaminated air and the influence of outside air currents and drafts; this condition should be obtained with the lowest possible value of Q.

308 The air velocity which must be developed by the exhaust hood is determined by the magnitude and direction of the air motion to be overcome and is not subject to direct and exact valuation.

The data pertaining to the air velocity requirements for various industrial processes are limited. The values presented in Table 1 are of some assistance in design since they indicate the order of magnitude of velocity requirements, but more particularly, they emphasize through their limited nature the need for a great deal of investigation in this connection.

Data for hood design may be collected in three ways:

(1) By measurement of actual air velocities generated by exhaust hoods now operating with *known* high efficiency.

(2) By direct experiment with full-scale model hoods. The process is isolated from other sources of contamination and the volume of air flowing through the hood is varied until satisfactory conditions are obtained, as determined by quantitative air analysis.

(3) In the case of visible dusts and fumes it is possible to determine visually the velocity necessary to turn the contaminated air, at various points in the zone of production, into a small portable testing hood by noting the distance from the hood when this occurs. Knowing the flow characteristics of the testing hood and the value of Q, one can quickly calculate the air velocity at the point in question. (Note: The extra expense involved in the experimental determination of air velocity requirements will generally pay for itself through the more efficient exhaust system thus secured.)

†Note: Hereafter in this report the volume of air flowing, in cubic feet per minute, will be denoted by Q.

TABLE 1—MINIMUM AIR VELOCITIES REQUIRED TO CAPTURE INDUSTRIAL DUSTS

Industry	Process	Required Air Velocity		Criterion
		At Point of Origin	Face of Hood	
Granite-cutting ...	Hand-pneumatic tool	200 f.p.m.		Reduced dust conc. to safe level
Granite-cutting ...	Surfacing machine	2000 f.p.m.		Reduced dust conc. to safe level
Granite-cutting ...	All tools		1500 f.p.m.	Reduced dust conc. to safe level
Grain elevators ..	Elevator boot and head, garner		500 f.p.m.	Visual test
Paint spraying ..	Spray booth		50-200 f.p.m.‡	
Sand pulverizing.	Bagging machine	400 f.p.m.		Reduced dust conc. to safe level
	Electric welding	100-200 f.p.m.		Visual test

‡Note: Depending upon the nature of the work and the size of the object being sprayed in relation to the size of the hood.

309 Certain theoretical considerations are of value in estimating the required air velocity:

(a) The *diffusion* velocity of gases and vapors into still air does not exceed 1 f.p.m. Natural convection currents are generally higher—25-50 f.p.m. In the absence of air motion from sources other than diffusion or natural convections currents, therefore, gases and vapors will require a *minimum* air velocity of say 60 f.p.m.

(b) Vertical convection currents, created by temperature difference or by the escape of lighter or heavier gases into air, varies with the square root of the difference in the densities of the column of rising gas and an equal column of surrounding air, thus:

$$V_{H_1} = K \sqrt{\Sigma \left[\rho_2 \right]_{H_1}^{H} - \Sigma \left[\rho_1 \right]_{H_1}^{H}} \quad \ldots\ldots\ldots\ldots (1)$$

Where

V_{H_1} = Vertical velocity in the rising column at any point H_1 feet above the operating level, f.p.m.

H = Height of column in feet from the operating level to the level where $\rho_1 = \rho_2$

ρ_1 = Density of air at any point in column H directly over heated surface

ρ_2 = Density of room air surrounding the rising column H

(c) It is easily shown that solid and liquid particles thrown off by dynamic projection cannot be captured by air motion acting in the opposite direction since the air velocity required is so high as to be impractical (as high as ten times the initial velocity of the particle, and not less than that required to transport particles horizontally or vertically, see item 402). It is best in this case to locate the hood opening, or part of it, in the path of the escaping material, thus utilizing its kinetic energy for its own capture and/or to employ suitable hood enclosures or baffles to break the passage of the large particles.

310 Design and locate the exhaust hood so as to provide the necessary air velocity with the lowest possible value of Q. The following general rules should be observed:

(a) Enclose the process as much as possible. The value of Q for an enclosing or semi-enclosing hood is determined by two factors:

(1) The air velocity through the openings in the enclosure must be great enough to prevent the escape of contaminated air at these points.

(2) The velocity within the enclosure must be high enough to prevent the settlement of undesirable material but in certain cases the velocity must *not* be high enough to carry away valuable product, unless a suitable trap is provided beyond the hood to recover the material carried away.

(NOTE: In the design of an enclosing hood particular attention must be paid to securing dust-tight joints around shafting, sliding or other moving parts of the process which must extend through the enclosing wall of the hood.)

(b) An exhaust hood which does not enclose the process should be placed with the opening as close as possible to the point of generation of the contaminating material since the air velocity in the zone of hood influence varies approximately inversely with the square of the distance from the hood opening.

(c) Shape the hood and provide flanges and other guiding vanes and baffles to create maximum air flow from the area of contamination and the least possible flow from the ineffective areas in which no polluting substance is dispersed, e.g., back of the face of the hood. If the area of production is long and narrow, use a hood of the same shape.

(NOTE 1: The air flow into an exhaust hood cannot be guided as effectively as the discharge of air from a nozzle since there is a basic *tendency* for a suction opening to draw air equally from all directions. A given air velocity can be established within a small area at a certain distance from the opening with a lower value of Q and less power consumption by *blowing* than by *exhausting*. This fact can sometimes be utilized effectively in hood design, but the positive air stream must not be permitted to strike any barriers. The development of eddies at the boundary of the positive air stream sometimes causes troublesome air currents with the consequent escape of contaminated air.)

(NOTE 2: The tendency for a suction opening to draw air equally from all directions becomes more marked as the distance from the opening increases until the distribution of flow becomes approximately the same for openings of all shapes.)

(d) Locate the hood opening, or part of it, so as to utilize the directional tendency in the motion of the contaminating air for its own capture.

311 The required value of Q for a given hood depends upon two factors; (1) the air velocity (V) to be created at the point of origin of the polluting substance, and (2) the shape and location of the hood. The required value of Q may be calculated by means of the following equations:

(a) Within a semi-enclosure, such as a spray booth

$$Q = V_h A_h \quad \ldots\ldots (2)$$

Where

Q = volume of air handled, c.f.m.
V_h = required air velocity at the face of the hood in f.p.m.
A_h = area of hood face normal to the airflow in square feet

EXAMPLE: A paint-spray booth 4 ft. × 5 ft. in area requires a total air flow of 2400 c.f.m. to produce a velocity of 120 f.p.m. past the object being sprayed within the hood.

(b) Outside an unobstructed exhaust hood,

$$Q = 10 V_x (X^2 + 0.1 A_h) \quad \ldots\ldots (3)$$

Where

V_x = required air velocity at the point of generation, f.p.m.
X = distance in feet from face of hood to point of generation
A_h = area of hood opening in square feet

EXAMPLE: Determine the total rate of air flow through a 3 in. × 6 in. hood located at a distance of 6 in. from a process requiring an air velocity of 400 f.p.m. for its control.

$$Q = 10 \times 400 \ (0.25 + 0.0125) = 1050 \text{ c.f.m.}$$

When the hood lays on a flat surface, Q in the equation may be reduced 25% for the same value of V; an equal reduction is permitted when a flange is added to the hood.

(c) The required value of Q for a hood suspended over a tank or table is given by DallaValle's equation:

$$Q = 1.4 \, V_{PD} P D \quad \ldots\ldots (4)$$

EXAMPLE: A hood 4 ft. × 6 ft. in dimension is suspended 2 ft. above a tank 3 ft. × 5 ft. in dimension. Determine the total rate of air flow into the hood necessary to maintain an average velocity of 50 f.p.m. through the open area between the tank and hood.

$$Q = 1.4 \times 50 \times 20 \times 2.06 = 2880 \text{ c.f.m.}$$

Where

V_{PD} = required air velocity through the open area between the hood and tank, f.p.m.
P = perimeter of hood in feet
D = distance from the outer edge of the tank or other surface to the edges of the hood suspended over it, in feet.

(d) Exhaust systems handling explosive dusts, fumes, vapors or gases must operate with sufficient air volume to prevent the development of explosive mixtures. This explosion hazard can be met also by the use of suitably conditioned inert gases wherever economically available.

312 STATIC SUCTION at the throat of the hood is commonly employed at the present time as an index of hood operation since it determines in part the value of Q for the hood. But Q varies, to a greater extent, with the area of the throat and the restriction coefficient of the hood, thus:

$$Q = 4000 \, A_t f \sqrt{SP} \quad \ldots\ldots (5)$$

Where

Q = volume of air flowing through the hood, c.f.m.
A_t = area of throat in square feet
f = restriction coefficient (varies from 0.95 to 0.3)
SP = static suction in inches of water at the throat of hood

Static suction does not constitute a basic specification for hood design and should be abandoned in fundamental codes. It is of assistance, however, as a simple index to be used in routine measurement of operation provided its magnitude is calculated for each hood from the required value of Q and the proper values of A_t and f (equation (5)), (see item 708).

Static suction at the throat of a hood is the negative pressure recorded by a vertical water manometer when attached to a piezometer opening in the wall of the branch pipe at a point where the flow is stable and the direction of air motion is parallel to the pipe wall. All exhaust hoods in the system must be open and in operation when the static suction readings are taken.

313 The determination of the velocity pressure, VP, in the branch pipe provides a more accurate measure of Q than is given by the static suction, SP, since a knowledge of the value of f is not required to calculate Q, thus:

$$Q = 4000 \, A_{VP} \sqrt{VP} \quad \ldots\ldots (6)$$

Where

A_{VP} = area of branch pipe at the section where VP is measured, square feet
VP = velocity pressure, ins. water

An objection to the use of VP is that it is difficult to measure accurately, especially in a short branch pipe with

bends in which the flow is not distributed symmetrically across the pipe. The determination of VP necessitates the use of a pitot-static tube and requires more skill than is necessary to determine the static suction.

314 The proper static suction or velocity pressure to be maintained in the branch pipe should be determined primarily by the transporting velocity required to convey the collected material (item 402).

Thus, there is no benefit in employing a static suction of 5 in. water (VP = 2.5 in. and V = 6300 f.p.m. when f= 0.7) when the required transporting air velocity is only 4000 f.p.m. (SP = 2.0 in. and VP = 1.0 in. when f = 0.7). If, in this case, a static suction of 2 in. produces insufficient air flow through the exhaust hood to effect adequate control of the contamination, the condition should be improved by increasing the area of branch pipe and not by increasing SP or VP.

315 Static suction values which have been determined by past experience to give satisfactory results should be converted into values of Q by means of the above equation (see 312).

EXAMPLE: In the New York Code, a static suction of 2 in. is required and the branch pipe diameter specified by the Code varies from 3 in. to 6 in. for different sizes of grinding wheels. Since the value of f is assumed to be 0.7, the requirements of the New York Code can be readily converted into basic rates of air flow, thus (from table on p. 11, Bulletin 12, New York Department of Labor):

MINIMUM AIRFLOW FOR GRINDING WHEEL HOODS* (N. Y. Code)

WHEEL DIA., IN.	WHEEL THICKNESS, IN. NOT OVER	MAXIMUM WHEEL SURFACE, SQ. IN.	REQUIRED AIR FLOW, Q C.F.M.
6	1	19	200
6-9	1½	43	270
9-16	2	101	355
16-19	3	180	450
19-24	4	302	556
24-30	5	472	800

*NOTE: These data are presented simply as an example; they are not necessarily recommended by the subcommittee. Other tables of experience can be converted in the same way and thus permit the continued use of valuable data in improved form.

IV. Exhaust Piping

401 PURPOSE:

(a) To connect exhaust hoods to a central source of suction.

(b) To insure proper distribution of flow from various hoods.

(c) To insure adequate air velocity for the pneumatic transport of the collected material to a central air-cleaning plant and point of discharge.

402 TRANSPORTING VELOCITY:

(1) Vapors and gases mix intimately with the air and may be moved as air may at any convenient velocity, which is determined by economy of pipe sizes and power consumption.

(2) Solid particles require certain minimum air velocities for pneumatic transport which vary with the size, shape and density of the material. The required velocity is higher for vertical lift than for horizontal movement.

The vertical velocity of an air stream necessary to keep a large particle (greater than 0.2 mm.) from falling is given by the approximate relationship:

$$V_v = K\sqrt{\frac{pS}{\rho}} \qquad \text{.....(7)}$$

Where

V_v = vertical velocity, f.p.m.
p = particle diameter, feet
S = specific gravity of the material
ρ = air density in lb. per cu. ft.
K = constant which has the following values:

Shape of particle	K
Sphere	4500
Rounded	3700
Average	3200
Elongated	3000
Flattened	2600

Actual transport velocities must be higher than the values given by this equation since it desired to lift the particle, not simply arrest it.

In general, no distinction is made between vertical and horizontal transporting velocities (although a difference exists when the area of the main is made 25% greater than the sum of the areas of the upstream branches). It is clear, however, that less work is required to move particles horizontally than vertically. Experimental determination of minimum transporting velocities is necessary in many cases.

403 A CHIP TRAP installed in the exhaust pipe close to the hood serves to reduce the required transporting air velocity by causing the removal of large particles at this point and also collects foreign bodies dropped into the hood, thus preventing blocking of the exhaust pipe. Chip traps are commonly designed with a cross-sectional area eight times the pipe area. The pressure-loss imposed by a chip trap should not exceed the reduction in pressure-loss in the pipe line made possible by the lower transporting air velocity. (NOTE: Objections to the use of chip traps: the collected material is not brought to a single central point; liability of greater leakage. Chip traps require frequent dumping; automatic traps which open when the exhaust fan is shut down are not recommended.)

404 METHOD OF PROPORTIONING PIPE SIZES. Two basic factors which determine pipe sizes are:

(a) Area at any section should not exceed $\frac{Q}{V}$ where Q is the volume of air flowing past the section and V is the minimum air velocity required for pneumatic carrying of the dust (item 402).

(b) The pressure-loss produced by the required amount of air flowing in any branch line should equal that created in that part of the system which lies upstream of the branch when the proper rate of airflow exists in it. For permitted variation in the rate of airflow, see Section 408.

405 PRESSURE LOSSES.

(a) Entrance loss into hood (also termed orifice loss) is determined by formula:

$$h_e \text{ (in. water)} = \left(\frac{1-f^2}{f^2}\right) VP \qquad \text{.....(10)}$$

Where

f = coefficient of restriction
VP = velocity pressure in the connecting pipe, in. water.

Average values of f and h_e are given in Table 2:

TABLE 2

TYPE OF OPENING	f	h_e
Flanged, gradual opening	0.95	0.11 VP
Average hood	0.70	1.0 VP
Enclosing hood, opening = throat area	0.50	3.0 VP

When the area of the opening into the hood is smaller than the throat area, f is less than 0.5 and h_e is greater than 3.0 VP.

(b) Friction loss in a round pipe is determined by means of the following general equation:

$$h_p = K \frac{LV^n}{D^{5-n}} \cdot \rho$$

Where

h_p = pressure loss in the pipe, in. water
L = length of pipe, ft.
V = air velocity, f.p.m.
D = pipe diameter, ft.
ρ = air density, lb. per cu. ft.
n = exponent which varies with nature of pipe surfaces
K = constant

In the simplest form of this equation, commonly employed until recently, n was assumed equal to 2.0, and the equation could be written:

$$h_p = \frac{L}{K'D} \cdot VP \qquad (11)$$

K', which varies with roughness of the pipe walls, is generally taken as 40 for average exhaust piping, i.e., $h_p = 1.0\ VP$ when $L = 40D$. It is known, however, that K is not constant for different values of D and V and in one variation of the equation

$K' = K'' \sqrt{D}$ and equation (11) becomes

$$h_p = \frac{L}{78D^{1.5}} \cdot VP \qquad (11a)$$

Actually, $n = 2.0$ only for very rough pipe surfaces or extremely high velocities whereas for average exhaust piping a better value is $n = 1.85$. Thus the equation becomes

$$h_p = \frac{K \rho LV^{1.85}}{D^{1.15}}$$

In this equation K does not vary with pipe diameter or with velocity and for average exhaust piping has the value $K = 5 \times 10^{-5}$. Thus,

$$h_p = \frac{5 \times 10^{-5} \rho LV^{1.85}}{D^{1.15}} \qquad (12)$$

or

$$h_p = \frac{L}{57D^{1.15}} \left(\frac{V}{4005}\right)^{1.85} \cdot \frac{\rho}{0.075} \qquad (12a)$$

This equation agrees with the relationship given in recent reference books.

(c) Miscellaneous loss introduced by bends, transition pieces, entrance losses, etc., must be estimated in each case. The accompanying Table 3 will be of material assistance.

406 Pipe Design

(a) Branches shall connect to the main at an angle not greater than 45° and near the large end of a tapered section. In dust exhaust systems, it is desirable to connect the branch at the top or side of the main.

(b) Simple elbows should be formed with smooth curves and with a center line radius of curvature not less than 2 pipe diameters to introduce minimum resistance, venturi-section elbows and other recent designs may be employed to give less resistance, especially where space is limited; the cost of special elbows may be prohibitive, however, when standard templets and methods of construction are not available.

(c) Enlargements shall be made on a gradual taper, preferably with bottom straight.

(d) Clean-outs shall be provided at points where dust is most apt to settle, i.e., at bends, junctions, dead-ends, at the foot of vertical pipes.

407 Choice of Pipes Sizes. It is not practical to adjust pipe sizes close enough always to insure the requirements in Item 404 because of manufacturing difficulties and because branch hose connections are often required of certain fixed diameters. Under these conditions, determine pipe size by Item 404(a) and provide if absolutely necessary suitable adjustable restriction placed close to the junction of the branch to the main by means of which the resistance may be adjusted. The application of restrictions must be done with a great deal of care and due consideration must be given to the kind of material being handled. For instance, on polishing systems where grease or similar substances are being used, restrictions may become coated and thus tend to close off the pipes. Special effort should be made to secure balanced flow in exhaust systems handling abrasive dust without the use of restriction pieces since they wear out rapidly under such conditions.

408 The actual volume of air flow, Q, developed in any exhaust hood shall not be less than the estimated minimum requirement. Flow in excess of the minimum does not reduce the efficiency of control but causes unnecessary power consumption and should be avoided by balanced pipe design.

409 Future Expansion.

(a) No additions shall be made to an existing exhaust system which causes a reduction in the flow through any hood below the estimated minimum requirement.

(b) New connections are best made to the main exhaust pipe, as near as possible to the cleaning-plant or fan.

(c) In certain cases, notably when expansion is contemplated very soon, it may be desirable to design the piping and fan for the ultimate system, only the needed part of which is built, and to provide orifices in the ends of the blanked-off pipe of sufficient capacity to admit enough air to maintain the required velocity of transportation.

(d) The most satisfactory way to provide additional exhaust ventilation is by means of a new independent system.

V. Air-Cleaning Plant

501 Purpose: Air-cleaning is required for several reasons: (1) to prevent the creation of a nuisance or hazard in the area around the outlet; (2) to prevent the recontamination of plant air from the outside; (3) to permit recirculation of air discharged from the exhaust system in the plant.

502 (a) Air-cleaning requirements vary with local conditions. The most rigid requirements must be met when the air is completely recirculated and the practice of returning the air to the plant should not be permitted except under the most favorable conditions of design, operation and maintenance. Minimum air-cleaning requirements apply to the isolated plant from which the exhaust air can be discharged without danger of recontaminating the plant.

(b) The concentration of polluting material in the discharged air shall not be high enough to create a hazard in the discharge area.

503 (a) Operating characteristics of the air-cleaning equipment shall be such as to give steady and continuous operation from the beginning to the end of a continuous working period and the storage capacity for the collected material shall be sufficient for this period of operation.

(b) See item 210.

504 Discharge Stack.

(a) The simplest means of disposal of contaminated air is through a high stack. Dilution with clean air and dispersion by favorable wind currents are depended upon to reduce the concentration to a safe level. Even in fully isolated locations the discharge stack gives questionable results and should be employed only as a last extreme.

(b) The nature and concentration of the escaping material and local meteorological conditions such as downdraft wind and eddies around buildings must be carefully considered since these determine the practicability of this method of disposal.

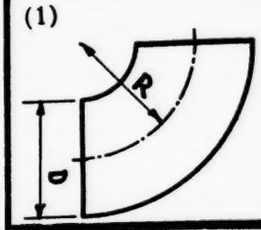
(c) Large particles which may settle out in the area adjacent to the stack should be removed in a settling chamber before discharging the air into the stack.

505 Primary Dust Separators.

(a) Gravitational settling chambers, cyclones and inertial separators serve to remove relatively large particles of dust but cannot be depended upon to capture minute particles of hygienic interest.

TABLE 3—PRESSURE LOSSES IN DUCT FITTINGS

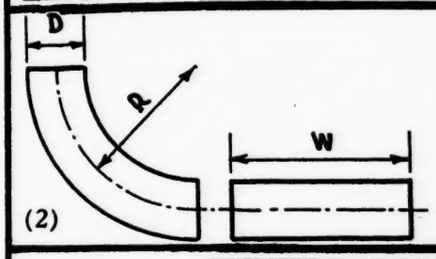
(1)



R/D*	h' in % VP	
	Round	Square
2.0	14.5	7.5
1.5	17	8.5
1.0	26	18
0.75	38	32
0.50	74	95

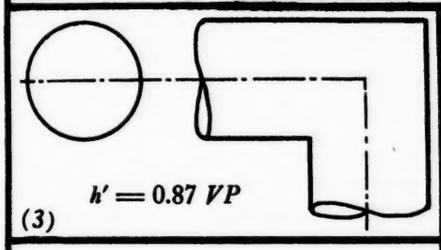
*Loss increases again when R/D>2.0

(2)



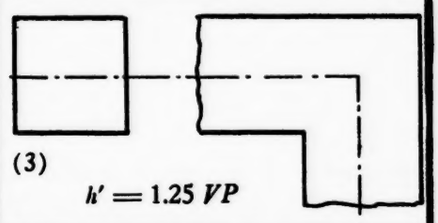
W/D	Loss in % h' for square pipe (No. 1)	
	R/D=1—3	R/D=0—½
4	90	73
3	95	80
2	100	90
1	100	100
0.5	133	115
0.25	215	130

(3)



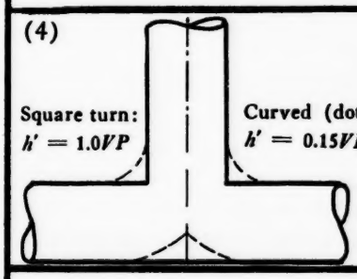
$h' = 0.87\ VP$

(3)



$h' = 1.25\ VP$

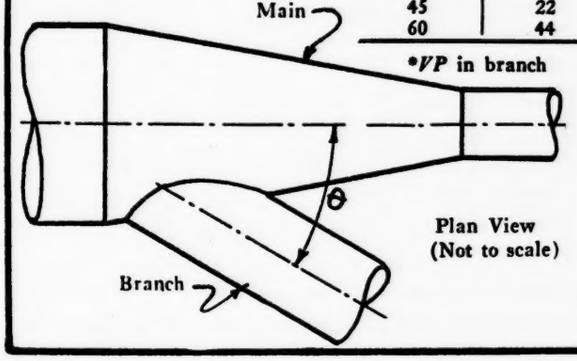
(4)



Square turn: $h' = 1.0VP$

Curved (dotted): $h' = 0.15VP$

(5) Entrance into main

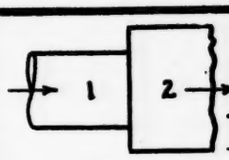


Angle θ	h' in % VP*
15	9
30	17
45	22
60	44

*VP in branch

Plan View (Not to scale)

(6) Abrupt expansion



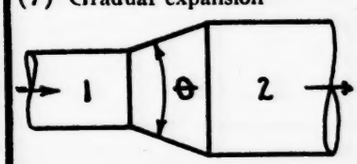
$Ne = \frac{\text{Area:1}}{\text{Area:2}}$

Ne	h' in % VP_1
0	100
¼	90
½	50
¾	20

(6a) Orifice

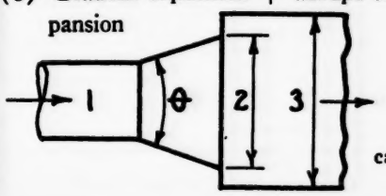
$h' = 2.8VP_B$

(7) Gradual expansion



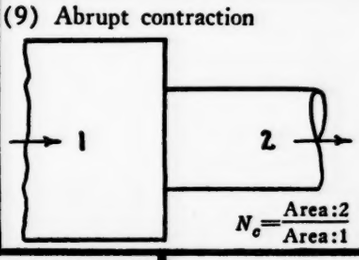
θ	Loss in % h' for abrupt expansion (No. 6)
>60°	100
38	70
24	50
17	40
11	30
7	20
4	28
2	50

(8) Gradual expansion + abrupt expansion



Loss = sum of losses calculated by No. 7 and No. 6

(9) Abrupt contraction

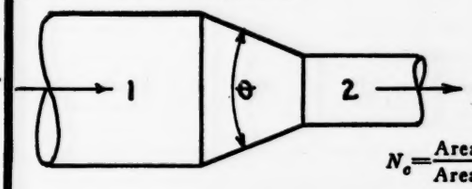


$N_c = \frac{\text{Area:2}}{\text{Area:1}}$

N_c	h' in % VP_2
0	34*
¼	30
½	21
¾	8

*Many authorities give $h' = 0.48VP$ when $N_c = 0$; above figures are for clean entrance free from rough edges.

(10) Gradual contraction



$N_c = \frac{\text{Area:2}}{\text{Area:1}}$

h' in % VP_2

Angle	N_c ¼	½	¾
10	.06	.04	.01
20	.14	.09	.04
30	.20	.12	.06
40	.24	.16	.07

(b) Primary dust separation may serve three purposes:

(1) Prevent the development of a nuisance from settling dust in the discharge area;

(2) Reduce the load of dust on filters;

(3) Useful materials are often salvaged in a primary chamber.

506 Stokes' law forms the basis for the design of dust separators of the gravitational and centrifugal type.

[*Editor's Note:* Here there are two sections omitted in this reprinting of the code; (a) considers the case of plain settlement, and (b) the case of centrifugal settlement. Formula and an example are given for each of these cases.]

507 (a) Properly designed cloth dust-filter, when not overloaded, and properly maintained, is capable of reducing the dust concentration in the filtered air to a level well within the safe limit of dustiness. Important factors of design are the nature and size of the dust, the dust load per cubic foot of air and the rate of filtration. The most common filtering velocity is 3 f.p.m., although there is wide variation in practice. Improper cleaning and maintenance and overloading are important factors contributing to poor filter operation.

(b) It is desirable to connect a differential manometer across the filter to provide a visual means of determining the degree of plugging of the fabric; to show when the filter needs cleaning as well as the effectiveness of the cleaning process.

VI. Exhaust Fan

601 Fan and motor capacity are determined by (a) the total volume of air flowing through the system and (b) the overall resistance or total pressure of the system. The power required is given by the equation

$$BHP = \frac{Q_t \times \textit{total SP}}{6356 \times ME} \qquad \text{.....(15)}$$

Where

BHP = brake horsepower
Q_t = total volume of air flowing, c.f.m.
total SP = over-all static pressure of the fan, ins. water
ME = mechanical efficiency (static) of the fan.

(a) Total volume of air flowing through the system equals the sum of the volumes flowing into the various hoods plus a certain percentage for leakage which varies with the excellence of design and installation and maintenance of the system. A common figure is 10%.

(b) Overall static pressure of the fan equals the absolute difference between the *static* pressure level at the outlet of the fan and the *total* pressure level at the inlet to the fan; in terms of gage pressures, the overall static pressure equals the sum (without regard to sign) of the static pressure at the outlet and the static pressure in the inlet pipe minus the velocity pressure in the inlet pipe.

602 Overall static pressure of the fan equals the sum of the following losses:

(1) Entrance into hood
(2) Resistance to air flow in branch pipe, including bends, enlargements
(3) Entrance into main pipe
(4) Resistance to air flow in main pipe, including bends, enlargements
(5) Resistance of cleaning plant, including entrance and discharge losses
(6) Resistance in main pipe from cleaning plant to fan
(7) Resistance to air flow in discharge main, including bends, enlargements, weather cap, etc.

This sum does not include the velocity pressure at the hood throat or at the inlet to the fan, although it has been common practice in the past to include the initial velocity pressure in the calculation. The velocity pressure at the fan outlet is never added.

603 Fans employed in exhaust systems handling explosive dusts and inflammable vapors shall conform to the American Standard Fire Protection Code for Blower and Exhaust Systems—Z33-1935, approved by the American Standards Association.

604 The exhaust fan in a system handling abrasive dust should be located on the clean-air side of the dust separator. Fans handling acid gases, other corrosive or abrasive materials shall be constructed of suitable resistant material.

605 Motors employed in an exhaust system handling explosive dust or inflammable vapors shall be located outside of rooms in which such materials are being generated and removed unless the motors are of type approved for the particular conditions or hazards.

VII. Construction, Maintenance

701 Hoods:

(a) Hoods shall be free from sharp edges and rough burrs and suitably reinforced when necessary. Rubber hoods are sometimes employed.

(b) Convenient and rapid-action adjusting and supporting devices are essential on movable hoods. Such devices shall be rugged and positive in action.

702 Piping:

(a) Exhaust piping not handling abrasive or corrosive substances and not subject to external wear is made of thin sheet metal with rivetted and soldered joints.

(b) Welded iron pipe, 1/16 in. — ⅛ in. wall thickness, is recommended for systems handling abrasive or corrosive substances and/or in locations where the pipe is subject to external wear or has to be taken down at intervals. Flanged and bolted and gasketed joints are recommended for heavy exhaust piping. Other materials such as cast iron, glass, lead, tile, etc., are required to resist corrosion in special processes.

(c) Exhaust piping shall be adequately supported (thin pipe at intervals not exceeding 12 ft.).

(d) Pipe shall be kept free from obstructions. (Note: Adjustable resistance devices and spark-arrestor screens shall not be considered as unnecessary obstructions.)

(e) Particular care must be taken to guard against leakage from pipes carrying contaminated air under pressure. This is best overcome by installing the air-cleaning plant on the suction side of the exhaust fan.

703 Exhaust fan and motor shall be mounted on a firm foundation and adequately protected from weather.

704 (a) All materials and details of mechanical construction shall conform to the provisions of the American Standard Fire Protection Code for Blower and Exhaust Systems—Z33-1935, approved by the American Standards Association.

(b) All electrical equipment for power lighting, and control shall be installed in accordance with the requirements of the National Electrical Code—C1-1935, approved by the American Standards Association, and for the specific conditions involved, such installations shall be subject to the approval of the Inspection Department having jurisdiction. Where necessary to install motors, lights, switches, or fan control in atmospheres presenting explosive possibilities, only such equipment as is approved for the specific conditions obtaining shall be used.

(c) Remote control for all blower or exhaust fans shall be provided in addition to any control located close to the equipment or within the room involved. Service or feeder switches controlling the circuit to the fan motor may fulfill this requirement when conveniently located and acceptable to the proper administrative authority.

705 (a) Methods of construction should be governed by the question of maintenance rather than by initial cost. The exhaust system should command as much care in its operation and maintenance as any other part of the plant equipment.

(b) Whenever possible, the manufacturers of plant machinery should incorporate the exhaust hoods in the design

of their machines. Consideration of the problem of exhaust ventilation before the machine is built will result, in most cases, in a more satisfactory solution than is given by the compromise that must be adopted in fitting the hood to the finished machine.

706 Proper operation and maintenance of an exhaust system should include: (1) Routine inspection and repair or replacement of worn and damaged parts; (2) proper maintenance of the fan and other moving parts; (3) operation of the air-cleaning equipment in accordance with the instructions of the designing engineer and the manufacturer of the equipment; (4) instruction to the workers in the proper use of the system for their maximum safety and comfort; (5) report to proper plant executive any wear, non-use or abuse of facilities.

707 Method of Testing Exhaust System for Efficiency of Operation.

(a) It is essential to make certain (1) that the design is fundamentally sound; (2) that the system is operated in accordance with the instructions of the designing engineer and the manufacturer of the equipment; (3) that the system be properly maintained.

(b) The measurement of concentration of polluting material in the atmosphere of the plant constitutes the basic means of measuring the effectiveness of control secured by an exhaust system. Suitable methods of sampling and measurement must be employed and the results compared with accepted standards[1] of permissible concentration of the contaminating substance.

(c) A few tests cannot be relied upon to give a true measure of control over a long period of time. A routine testing schedule is necessary which must be augmented by special tests whenever changes in the operations are made, such as adding new machines, changing the composition of chemicals which alters the rate of volatilization, etc.

(d) Measurements of Air Flow. Routine measurement of air flow through the system indicates whether it is operating in accordance with the original design. Measurement of static suction at the throat of the exhaust hood provides the simplest index of operation but it may be safely employed for this purpose, only when the coefficient of restriction, f, is not changed by damage to the hood. The measurement of the velocity pressure by means of a pitot tube[2] in the branch pipes and in the main pipe as well provides a more exact means of determining the volume of air flowing into the various hoods and through the system and in addition gives direct information concerning the transporting velocities in the system. The accurate determination of average velocity at any cross-section, however, requires more skill and time than is required for the determination of static suction. Care must be exercised to keep the pitot tube from plugging when used in measuring the velocity of dust-laden air. (Pitot tubes of special design have been used for this purpose.) In certain cases it is desirable to provide a flowmeter of some type in the main line to indicate the total volume of air handled by the system. A pitot tube may be employed for this purpose, although a meter section of the venturi type provides a more permanent measuring apparatus.

708 The exhaust system shall be kept in operation whenever any machines connected to it are in use.

[1] Note: An ASA National Advisory Committee on Toxic Dusts and Gases has been appointed to prepare standards of permissible concentration of various contaminating substances.

[2] Note: For the determination of low air velocities (below 1000 f.p.m.) the silvered Kata thermometer or other suitable velocity meter must be employed.

District Heating in Rochester

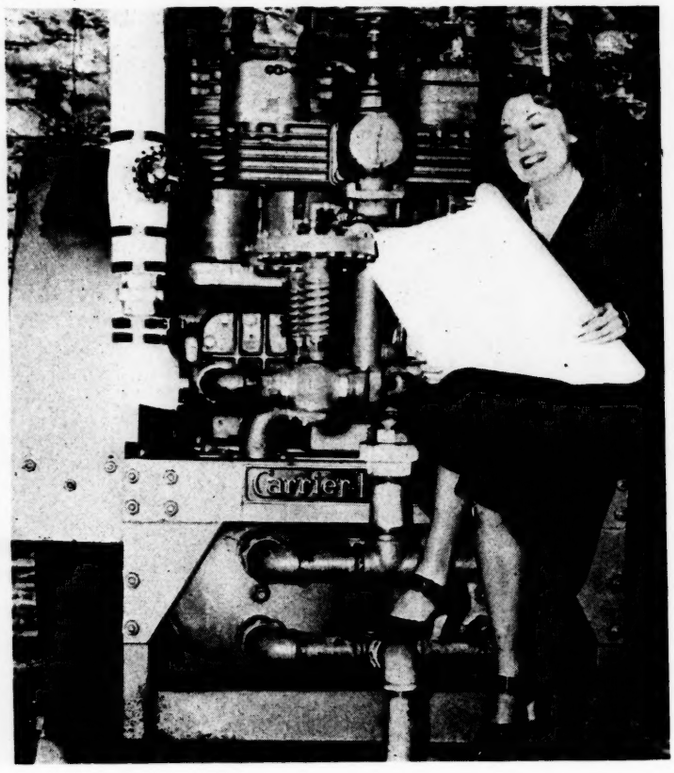
STEAM customers of the Rochester (N. Y.) Gas and Electric Corporation have increased in number from 254 in 1926 to 329 in 1936, a gain of 29.5%, according to that company's Year Book, an especially attractive publication issued in March. During the same period the company increased its coke sales 65%, from 135,980 tons in 1926 to 224,696 tons in 1936. In 1936 this utility had over 110,000 gas customers. Of the total gas sold to these customers 16.2% were for house-heating.

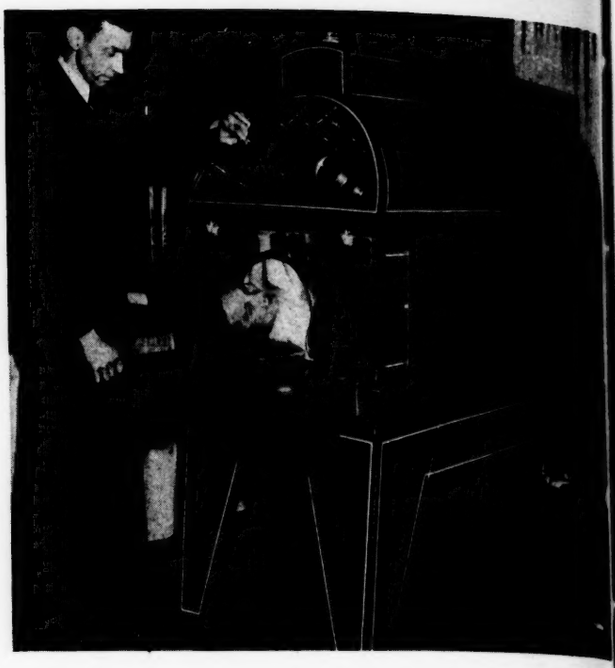
Concerning the company's steam production and distribution the Year Book says:

The steam production and send-out from all five of the company's district steam plants was greater in 1936 than in any year since 1930. The total send-out in 1936 was 1,387,983,000 lb. Station No. 3, in Rochester's central Genesee River factory district, showed a considerable increase due to improved industrial conditions. During 1936 construction progressed on another new 700-lb., 750°, 7000-hp., million dollar boiler at Station No. 3. This boiler will supply steam to the station's electric generators and will supplement, through bleeding and reducing valves, the station's steam send-out. Station No. 9 at Lincoln Park, Station No. 35 at Litchfield Street, Station No. 11 at Goodman Street, and Station No. 8 on Lawn Street, all have enjoyed additional business.

Because of new steam business and the increased demands for steam by present customers, the following major mains and services were constructed: An 8-in. high pressure booster steam main approximately 1000 ft. long was installed from a point just south of the Curtice Canning Company's plant on Curtice Street, near the east end of Smith Street bridge, to distributing Station No. 34, adjacent to Bausch and Lomb Optical Company. This main runs for a short distance overground along the crest of the Genesee river bank, then underground through the Curtice Company property and basements, and thence underground through the Bartholomay Brewing Company's property. The Bartholomay Brewing Company will be served from this main as soon as its boiler plant operation is discontinued. This main will increase the supply of steam available for distribution to the many important customers in this section and was particularly installed to handle the new loads at Aplo Clothing Company and at the Hickok Manufacturing Company. To reach the Hickok Company a new 4-in. high pressure steam main approximately 600 ft. long was constructed above ground along a railroad branch right-of-way and underground under a building materials supply yard to the Hickok Company's former boiler room. About 150 ft. of 4-in. low-pressure main was also constructed to serve the new stores, including Rudolph's, at the southeast corner of Main Street, and South Avenue.

BLONDE AIR CONDITIONING ENGINEER, Henriette Betlem, 25-year old Rochester, N. Y., girl, who started seven years ago in her brothers' air conditioning business, Betlem Heating Co., is now chief engineer of the firm.





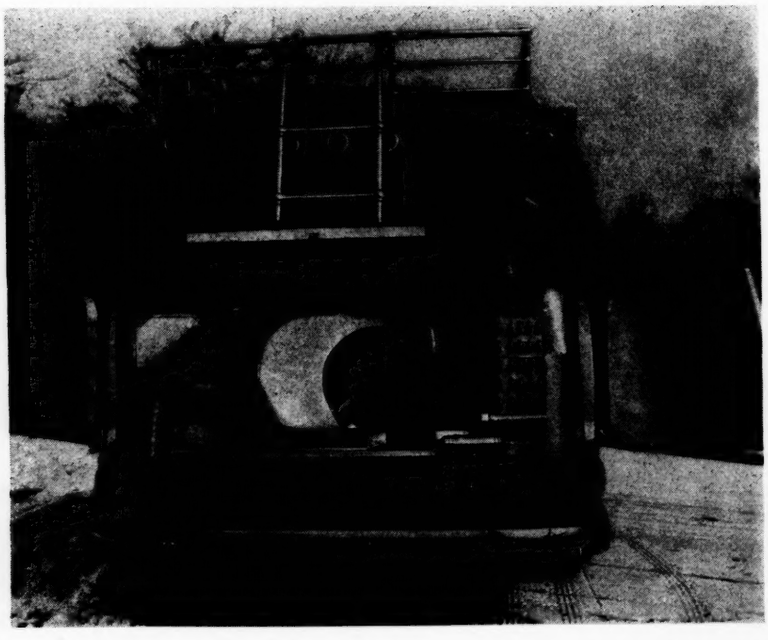
Wide World

AIR CONDITIONED FEVER BOX producing varying temperatures and used in fighting diseases which respond favorably to high temperatures.

PICTURE PARAGRAPHS

McNaught Syndicate, Inc.

"Something's gone wrong with our air conditioning—clouded up an' looks like rain!!"



AIR CONDITIONED LORD KELVIN, rear view, a research coach sponsored by Nash-Kelvinator and the White Motor Co. Completely air conditioned, this bus is making an exhibition tour through the south. (Above) Exhaust louvers for condenser cooling air. (Right) Duct distribution is beneath luggage racks with mushroom head outlets. Story on page 39.

Air Conditioning in Industry

Part 6—Improved Efficiency of Workmen

By MARY O. SOROKA†

The first five parts of this series of articles were devoted to the desirability and in many cases the necessity of air conditioning for the furtherance of manufacturing processes. This part deals with the effects of air conditioning on the workmen from the standpoint of improved efficiency, reduction of sickness, and lowering of the accident rate

IN previous articles the effects of air conditioning on organic and inorganic materials used in industry were reviewed. The topic under consideration here is another means toward increased production in the factory. Theoretically the human organism is equipped to adjust itself to correspond with atmospheric conditions, yet restaurants, retail stores, railroads, and moving picture theaters report profits in air conditioning for comfort. When industry air conditions the factory for comfort it finds profit from increased efficiency, reduction in sickness and accidents, all reflected in production costs.

Efficiency

One of the most recent applications of air conditioning for improved efficiency is that of the Ford automobile plant at Dearborn. The first sections to be air conditioned were the cylinder boring and honing department, two sand molding rooms in the foundry, the machine shop trade school, drafting room and factory offices. This new production tool has been so successful that it is being applied rapidly to other departments.

Air conditioning the cylinder department had a double purpose. In addition to the fact that men do not become so tired and hot, are able to keep up a faster pace and turn out more work, the new system will provide cylinders that are machined uniformly all day long. In this department the winter temperature is 70F-75F and in summer it is kept 15F lower than outdoors.

The main foundry has been conditioned although close temperature control is impossible owing to heat from the ladles of molten steel while casting is in progress. The closeness of steel mill, foundry, river boats, and locomotives made it difficult to keep drawings clean in the drafting room. They were redrawn often because of the dirt on them and when the temperature reached 100F as it often did in the summer, the men became drowsy and inactive. In winter the air was also oppressive. Complete air conditioning improved the drafting room so that drawings were clean and the men worked through the day more efficiently.

The success of the system is shown by the fact that it has been extended to four other sand molding rooms, to a new chemical and metallurgical laboratory, an X-Ray room, as well as others. The lacquer department and a number of inspection rooms are also conditioned.

One of the advantages of complete air conditioning is the fact that noise is reduced because windows must be kept closed. In some studies made by a large telegraph company it was found that noise abatement reduced errors by 42%. It has been claimed that excessive noise costs the employer at least $5 out of every $100 on his payroll and it costs the employes more in terms of fatigue due to energy required to turn out any given amount of work. While our ears get used to noise our nerves never do. Doctor Laird of Colgate University discovered that workers doing identical jobs under the same conditions except for increased noise use up 19% more energy in working in a noisy atmosphere.

Detailed studies of the financial benefits of air conditioning were made at the Philadelphia plant of a cigar manufacturing company in which complete all-year-round air conditioning had been installed. Although some doubt existed as to whether the savings would be sufficient to offset the installation and operating costs, the benefits far exceeded expectation. During normal summer weather the temperature and humidity conditions in the plant would cause production to fall off from 4000 cigars per machine per day to 3600 cigars per machine per day, a decrease of 10%. With complete air conditioning, the machines are worked at their full capacity of 4000 cigars.

Under normal summer conditions without air conditioning an average of 50 girls per day for 75 days would

†Engineer, Julien P. Friez & Sons, Inc., subsidiary Bendix Aviation Corp., Baltimore, Md.

become sick or indifferent to their work and would work one-half day, leaving at noon. After the factory was air conditioned this was reduced to an average of 5 girls out one-half day for 75 days. Furthermore, due to the discomfort, many would leave their factory jobs to become waitresses at summer resorts. The air conditioning system reduced the labor turn-over by 100 girls during the summer thereby materially decreasing training expenses. More comfortable working conditions increased the efficiency of workers to such an extent that rejects were reduced from between 3 and 4% to between 0.5 and 1%.

The gross savings made from reduction in lost time, reduction in labor turn-over, reduction in rejects, and increase in production amounted to $29,546 per year. Since the total owning and operating cost of the added air conditioning was $6,174.50 per year, there was an outright profit of $23,371.50 per year. According to the owner the installation has resulted in a general improvement in the health of employes which is beyond evaluation.

Sickness

At the main plant of the International Business Machines Corporation at Endicott, N. Y., the success of the air conditioning system in the engineering laboratory was responsible for the decision to air condition the main machine shop. In this department the high heat loads from machines and occupants made it difficult to provide proper ventilation for comfort. The number of colds contracted in the machine shop and treated in the medical department was in far greater proportion to the number of men employed than in the rest of the factory. The manufacturing units located in the air conditioned area are the drill press, milling machine, hand screw machine, grinding, gear cutting, maintenance, straightening and bench work, tool making and special machine department. The results show a decrease of 50% in colds among employes.

The largest camera and photographic film manufacturer is reported to have conducted experiments in one of its plants and to have observed a 50% decrease in illness among employes in spaces supplied with clean air at the right temperature and humidity and a 4% increase in output. Statements by executives tell of marked improvements in health and efficiency due to air conditioning.

Accidents

Much publicity has attended the air conditioning of South African gold mines in the Rand district but air conditioning for mines was established as a sound business investment in 1920 with the installation of a cooling plant for the Morro Velho mine in Brazil. One of the results of the installation was the fall in the accident rate. In the 16 months previous to the starting up of the plant 20 deaths occurred through underground accidents and 4 cases of disablements, the total liability for compensation involved in connection with these accidents being 80,675 milreis. In the following 16 months there were six fatal accidents underground and four cases of disablement, the amount of compensation involved being 35,820 milreis.

Miners are more alert when heat and humidity are not excessive and the liability to cuts and abrasions is lessened because clothing is no longer discarded leaving the skin without protection. Everyone is familiar with state labor laws making compulsory removal of dusts, gases and fumes dangerous to health. Protection against dangerous temperatures and humidities is voluntary but may result in savings which offset the cost in providing it.

The list of occupations in which industrial workers are exposed to extremes of heat and cold, dampness and sudden changes indoors is long. There are artificial ice makers, brick makers, cement workers, coke oven workers, cold storage plant workers, dry cleaners, dye makers, electroplaters, foundry workers, furnace workers, glass makers, ice cream makers, illuminating gas workers, iron and steel workers, laundry workers, match factory workers, packing house employes, petroleum refiners, pottery workers, smelters, soap makers, tannery workers, vulcanizers, wall paper printers, welders, and others.

The seventh and concluding installment of this series will appear in the next issue.

British Union Demands Better Heat

G. C. AMMON, member of Parliament for North Camberwell, is sponsoring a bill in the House of Commons to secure legislation for warmer offices in the United Kingdom. Behind him are organizations with more than a million members—clerks, shop salesmen, municipal employes, draftsmen, etc.

Miss B. Anne Godwin, organizing secretary of the Association of Women Clerks and Secretaries, has collected the data for the campaign to get this bill passed. Working conditions in offices, she says, are not at present governed by any protective legislation.

"Side by side with imposing, well-equipped new blocks," declares Miss Godwin, "are houses converted for commercial use. They frequently have insufficient heating. Many are underground and damp. In some of these offices stenographers have to work in overcoats for the greater part of the year. Their hands are so cold and covered with chilblains that their work must inevitably suffer.

"In one office we discovered that the heating was so poor and the draft so bad that, although the stenographer erected a barricade of rugs and newspaper round her knees, she became seriously ill with sciatica. There is really no excuse for primitive methods of heating some employers seem to think sufficient today."

As there are thousands of offices in London without central heating arrangements, the heating and ventilation problem is a complicated one. Summer or winter, the only method of obtaining fresh air in many cases is by throwing open the windows. Although in fine weather the open window may be agreeable, it means interruption from external noises and also drafts, changes of temperature, and circulation of dust and dirt.

Degree-Day Assists in Operating Heating Plant at Cincinnati General Hospital

Part 2—Use of the Degree-Day

By ANTHONY A. FETTE†

The heating and power plant at the Cincinnati General Hospital is a good example of an institutional plant extended from time to time as necessary and operated to secure maximum economy. With a hot water heating plant operated in strict accordance with outside temperature changes, the heat consumption would be expected to parallel outside temperature almost exactly. Use of the degree-day as a yardstick for measuring results in such a plant is a "natural". But with the plant being started at 60F outside temperature instead of the 65F often used elsewhere, a whole new set of degree-day figures based on 60F was developed for this plant. With this information at hand the degree-day was applied to the daily operations by furnishing the operators with simple tables and forms.

The degree-day application is explained in this article. Part 1, see pages 33 to 36, HEATING & VENTILATING, April, 1937, was devoted to a description of the principal features of the hospital plant. — Editor.

OUTSIDE temperature is the controlling factor in the operation of the heating system. At the power plant a chart is posted showing the desired temperature of the hot water leaving the plant at various outside temperatures (Fig. 1). This chart has been constructed as the result of experience in operating the plant. It will be noted that the line is not straight. The operator observes the outside temperature and regulates the speed of the circulating pumps and the admission of steam to the exhaust lines until a thermometer in the circulating water main shows that the leaving water is at the temperature indicated on the chart.

The heating system is started when the outdoor temperature drops to 62F on a windy day, 58F on a calm day, or ordinarily when the temperature reaches 60F. In mild weather only one pump is operated; as the temperature approaches 20F outside a second pump is started, while the third is put into operation when the temperature outside approaches zero.

With one pump operating the pressure difference between the supply main and the return main is from 10 to 12 lb.; with two pumps, it is 20 to 22 lb.; with three pumps operating the difference is 30 to 35 lb. The static pressure at the pump discharge level is about 60 lb. per sq. in.

On January 23, 1936, a day when the outside temperature averaged 2.45F below zero over the 24-hr. period, the water left the plant at 165F and returned at 150F with a pump differential pressure of 30 lb.

Records of Heating Hours and Outside Temperatures are Kept

Operators keep an accurate record of the number of hours each day when the heating system is operated. A check of this time against the number of hours when

†Mechanical Director, Cincinnati General Hospital.

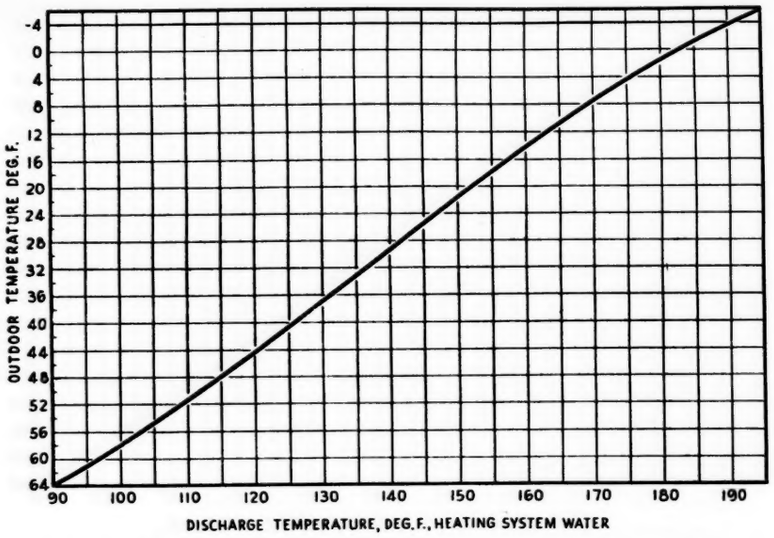


Fig. 1. Relation between outside temperature and temperature of water leaving power plant.

the temperature is reported below 60F by the Weather Bureau is also kept. It is interesting to note that for 1935, for instance, the number of hours when the heating system was in use was 5283, while the Weather Bureau records showed that the outside temperature was below 60F for 5237 hr. By the Bureau record heating would have been required over 218 days while the plant actually operated 220 days. The agreement between these two sets of independently collected data is thus very close.

In a plant where operation is controlled by the outside temperature, naturally a careful record is kept of the outside temperature. The daily record is averaged in order to get a day-by-day statement of outside temperature and at the end of each month the daily temperatures are averaged to get an average monthly temperature. When these are compared with similar temperatures reported by the Weather Bureau, they are found to be in very close agreement. For instance, the figures for the year 1935 by months are shown in Table A.

System of Degree-Days is Used

Although the heating plant is put into operation when the outside temperature reaches 60F, the base of the degree-day system for this plant has been set at 60F. As the usual computations for degree-days use a base of 65F, it has been felt that the degree-days for Cincinnati should be recomputed to a 60F base in connection with operation of this plant.

On this assumption the degree-day as used at the hospital is defined as 60 minus the average daily temperature times the number of days. Thus, in January, 1934, the average temperature for the month was 36F, and since there are 31 days in January, the number of degree-days for that month is considered to be (60 — 36) x 31, or 24 x 31 = 744 degree-days. Tables have been prepared in order that degree-days may be determined without mathematical calculations. As an example of how these tables are set up, Table 1 gives the number of degree-days from 1927 to 1935, inclusive, during the months of the heating season.

Other tables have been worked up whereby as soon as the average monthly temperature and the number of days are known, the number of degree-days may be read off at a glance. Such a table greatly simplifies calculations but is not given here because of the space required.

Daily Operating Records on a Degree-Day Basis

The operation of the heating plant is in charge of operators who work on 8-hr. shifts. At the end of each 8-hr. period the operator writes in on a form (Fig. 2) furnished to him, a record of how many of the circulating pumps he has had in operation. He also records the average outside temperature which he arrives at by recording the temperature each hour during the time he is on duty.

The operators also have available tables which have been prepared showing the degree-days of heating per degree below the 60F base temperature. There is a table (Table 2) for use when the pumps have been in

TABLE A

Month	Hospital Record	Weather Bureau Record
January	33.40	33.40
February	35.10	35.20
March	48.70	49.40
April	50.90	50.50
October	55.40	57.20
November	43.90	44.10
December	29.00	27.20
Average	42.34	42.43

TABLE 1

Heating Season	October	November	December	January	February	March	April	Total
1927-28	12.4	336.0	824.6	892.8	765.6	601.4	330.0	3762.8
1928-29	6.2	462.0	719.2	954.8	901.6	334.8	102.0	3480.6
1929-30	182.9	576.0	793.6	905.2	476.0	589.0	102.0	3624.7
1930-31	186.0	450.0	849.4	765.7	593.6	682.0	198.0	3724.7
1931-32	18.6	189.0	542.5	576.6	504.6	737.8	222.0	2791.1
1932-33	130.2	564.0	799.8	601.4	722.4	567.3	213.0	3598.1
1933-34	161.2	528.0	663.4	744.0	974.4	638.6	195.0	3904.6
1934-35	68.2	348.0	824.6	855.6	694.4	328.6	285.0	3404.4
1935-36	86.8	477.0	1016.8	1078.8	962.8	409.2	324.0	4355.4

TABLE 2

Hr.	D.-D.	Hr.	D.-D.	Hr.	D.-D.	Hr.	D.-D.	Hr.	D.-D.	Hr.	D.-D.
0.25	0.0104	4.25	0.1771	8.25	0.3437	12.25	0.5104	16.25	0.6771	20.25	0.8437
0.50	0.0208	4.50	0.1875	8.50	0.3542	12.50	0.5208	16.50	0.6875	20.50	0.8542
0.75	0.0312	4.75	0.1979	8.75	0.3646	12.75	0.5312	16.75	0.6979	20.75	0.8646
1.00	0.0417	5.00	0.2083	9.00	0.3750	13.00	0.5417	17.00	0.7083	21.00	0.8750
1.25	0.0521	5.25	0.2187	9.25	0.3854	13.25	0.5521	17.25	0.7187	21.25	0.8854
1.50	0.0625	5.50	0.2292	9.50	0.3958	13.50	0.5625	17.50	0.7292	21.50	0.8958
1.75	0.0729	5.75	0.2396	9.75	0.4062	13.75	0.5729	17.75	0.7396	21.75	0.9062
2.00	0.0833	6.00	0.2500	10.00	0.4167	14.00	0.5833	18.00	0.7500	22.00	0.9167
2.25	0.0937	6.25	0.2604	10.25	0.4271	14.25	0.5937	18.25	0.7604	22.25	0.9271
2.50	0.1042	6.50	0.2708	10.50	0.4375	14.50	0.6042	18.50	0.7708	22.50	0.9375
2.75	0.1146	6.75	0.2812	10.75	0.4479	14.75	0.6146	18.75	0.7812	22.75	0.9479
3.00	0.1250	7.00	0.2917	11.00	0.4583	15.00	0.6250	19.00	0.7917	23.00	0.9583
3.25	0.1354	7.25	0.3021	11.25	0.4687	15.25	0.6354	19.25	0.8021	23.25	0.9687
3.50	0.1458	7.50	0.3125	11.50	0.4792	15.50	0.6458	19.50	0.8125	23.50	0.9792
3.75	0.1562	7.75	0.3229	11.75	0.4896	15.75	0.6562	19.75	0.8229	23.75	0.9896
4.00	0.1667	8.00	0.3333	12.00	0.5000	16.00	0.6667	20.00	0.8333	24 00	1.0000

Hr.—Number of hours heating system is in service (expressed as a decimal for which 0.25 is 15 min., 0.50 is 30 min., etc.
D.-D.—Degree-days per degree of heating and is to be multiplied by (60 minus aver. temp.) for hours heating system is in service.

operation less than 8 hr. and another table to cover those days when pumps are in operation during the entire 8-hr. period. This table, being prepared by steps of 1/10F of variation, is so long that it is not reproduced here in full. However, a portion of it (Table 3) between the range of 45.7 and 44.4F is shown as an example. It will be noted that opposite 44.7 on this table is found the figure 5.1000 which is entered in the operator's daily report sheet. Similarly, opposite the figure 45.1 will be found the number 4.9667 which is also shown on the sample of the daily form reproduced here.

With these tables and with this daily form the number of degree-days of heating is recorded by the plant operator and is therefore available for the plant records every day.

This simplification of the degree-day tables and their reduction to a basis whereby the plant operator can quickly compute number of degree-days permits the degree-day to be used to good advantage in the plant operation.

TABLE 3

Aver. Temp.	D.-D.	Aver. Temp.	D.-D.
45.7	4.7667	45.0	5.0000
45.6	4.8000	44.9	5.0333
45.5	4.8333	44.8	5.0667
45.4	4.8667	44.7	5.1000
45.3	4.9000	44.6	5.1333
45.2	4.9333	44.5	5.1667
45.1	4.9667	44.4	5.2000

CINCINNATI GENERAL HOSPITAL - - - OPERATION OF HEATING SYSTEM

DATE: Thursday, Feb. 18, 1936

Shift No.	Turbines Numbers	Hr. Heating System in Service	Aver. O. D. Temp.	No. Deg. Days Heating	Remarks
1	1,2+3	8	39.1	6.9667	#1 Turbine off @ 9:30 A.M.
2	2+3	8	44.7	5.1000	
3	2+3	8	45.1	4.9667	
Total			42.96	17.0334	

Fig. 2. Operator's daily report form.

Results

It is of interest to note that for 1935 the steam actually charged for heating purposes was 98.2 lb. per 1000 sq. ft. of radiator surface per degree-day. This corresponds to a steam consumption of 376.4 lb. per season per square foot of radiator surface.

Performance of Oil-Fired Warm-Air Furnaces

By A. P. KRATZ† and S. KONZO‡

Studies at the University of Illinois Research Residence during recent heating seasons have yielded valuable data regarding performance of conversion burners and specially-designed oil-burning furnaces. Included in these data are comparisons of the two types of systems, together with results of tests on the effects of varying the rate of oil supply, excess air, flue gas temperature, and other variables. The material in this article is condensed from or based on a paper presented by the authors at the 43rd annual meeting of the American Society of Heating and Ventilating Engineers in St. Louis in January, 1937.

RESULTS from investigations on the performance of a warm-air furnace equipped with a conversion oil burner and a specially designed warm-air furnace intended for oil burning were recently made available. These investigations, conducted at the University of Illinois Research Residence, resulted in some important conclusions being drawn among which the following are of interest:

(1) The capacity and efficiency of oil-burning warm-air furnaces are dependent upon seven factors: Type of burner; rate of oil input; percentage of CO_2 in flue gas; condition of draft in combustion chamber; amount and location of heating surfaces; size and shape of combustion space; quantity of circulating air.

(2) With a constant percentage of CO_2 in the flue gas, and a constant rate of oil input, the efficiency and capacity of the furnaces using oil as a fuel were increased when the quantity of air circulated was increased.

(3) With a constant quantity of air circulated and a fixed rate of oil input to the furnaces using oil, the capacity and efficiency of the unit were not materially increased when the CO_2 content in the flue gas was increased from 9.5% to 11.5%.

If furnaces using oil as a fuel are provided with sufficient effective heating surface for a given rate of oil input, so that the temperature of the leaving flue gases will be low, then the unit may be expected to perform satisfactorily under diverse conditions of installation in the field, even with fairly wide deviations in the adjustment of the fuel-air ratio for the oil burner.

(4) Under normal service conditions, the operation of the burner for relatively short periods, during which a high rate of combustion was maintained, was not so good from the standpoint of fuel economy as the operation of the burner for longer periods, during which a lower rate of combustion was maintained.

(5) For an average heating day, or a day on which the indoor-outdoor temperature difference was 33F, the requirements of the oil-burning furnace as compared with the requirements of the conversion unit showed a net reduction in fuel oil of 11.5 lb. per day and a net reduction in electrical energy of 0.2 kw-hr. per day.

†Research Professor, Engineering Experiment Station, University of Illinois.

‡Special Research Associate, Engineering Experiment Station, University of Illinois.

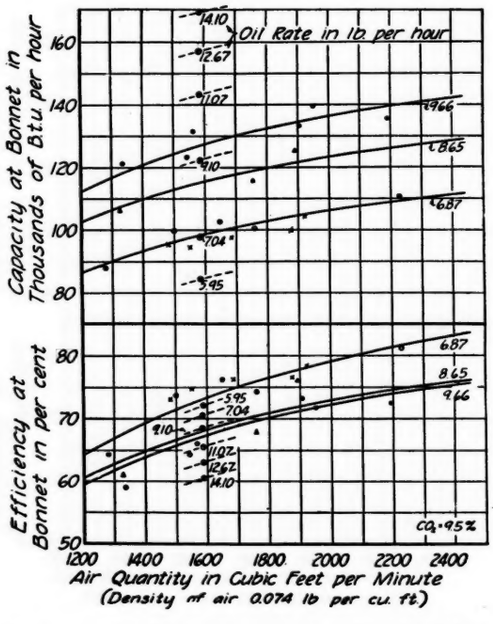


Fig. 1. Performance curves of conversion unit in forced air heating system.

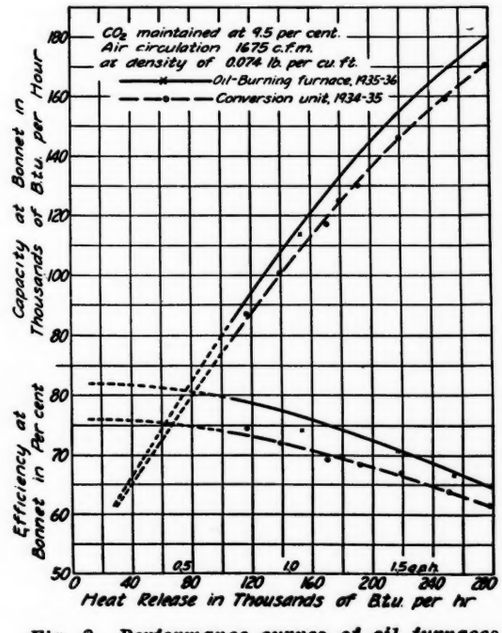

CO2 maintained at 9.5 per cent.
Air circulation 1675 c.f.m.
at density of 0.074 lb. per cu. ft.
Oil-Burning furnace, 1935-36
Conversion unit, 1934-35
Capacity at Bonnet in Thousands of Btu. per Hour
Efficiency at Bonnet in Per cent
Heat Release in Thousands of Btu. per hr

Fig. 2. Performance curves of oil furnaces in the Research Residence.

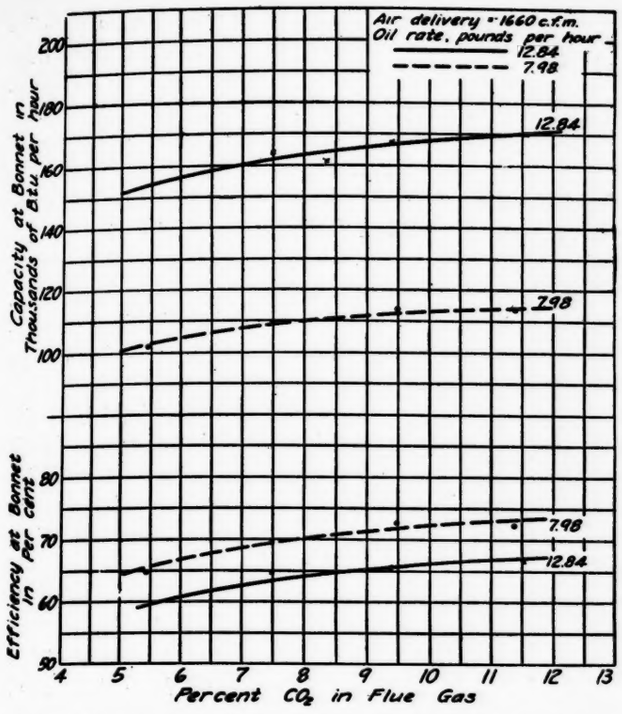

Air delivery = 1660 c.f.m.
Oil rate, pounds per hour
12.84
7.98
Capacity at Bonnet in Thousands of B.t.u. per hour
Efficiency at Bonnet in Per cent
Percent CO_2 in Flue Gas

Fig. 3. Performance of an oil-burning furnace with various percentages of CO_2 in the flue gas.

(6) For the same weather conditions, the heat inputs to the furnace were less and the overall efficiencies were greater for anthracite than for oil.

The temperature of the flue gases alone is not a reliable index of combustion efficiency when comparing different fuels. In fact, the total amount of the net flue gas loss during a 24-hr. period, rather than the combustion efficiency alone, determines the magnitude of the heat input required to maintain house temperatures.

The Test Plant

The investigations reported cover two seasons: That for the heating season of 1934-1935 was undertaken to determine the performance and operating characteristics of a warm-air furnace equipped with a conversion oil-burning unit. For the heating season of 1935-1936 the conversion oil-burning furnace unit was replaced with a warm-air furnace designed specifically for oil combustion, and the performance and characteristics of the furnace were compared under identical conditions of operation with those obtained with the conversion unit.

The Research Residence is a three-story structure of standard frame construction. The calculated heat loss is approximately 137,500 B.t.u. per hr. at an indoor-outdoor temperature difference of 70F, and approximately 159,000 B.t.u. per hr. at an indoor-outdoor temperature difference of 80F. The residence is completely furnished, and during the heating season it was occupied by four people.

The heating plant consisted of a warm-air furnace used in connection with a forced-air heating system. The furnace used during the heating season of 1934-1935 was of the cast-iron, circular-radiator type, having a 27-in. firepot and 23-in. grate, and was equipped with a casing 50 in. in diameter. In order to accommodate the gun-type oil burner which was inserted through the ash-pit door of the furnace, the grates were removed and firebrick were arranged to form a cylindrical combustion space. Hereafter this combination of the furnace and burner will be referred to as the conversion unit.

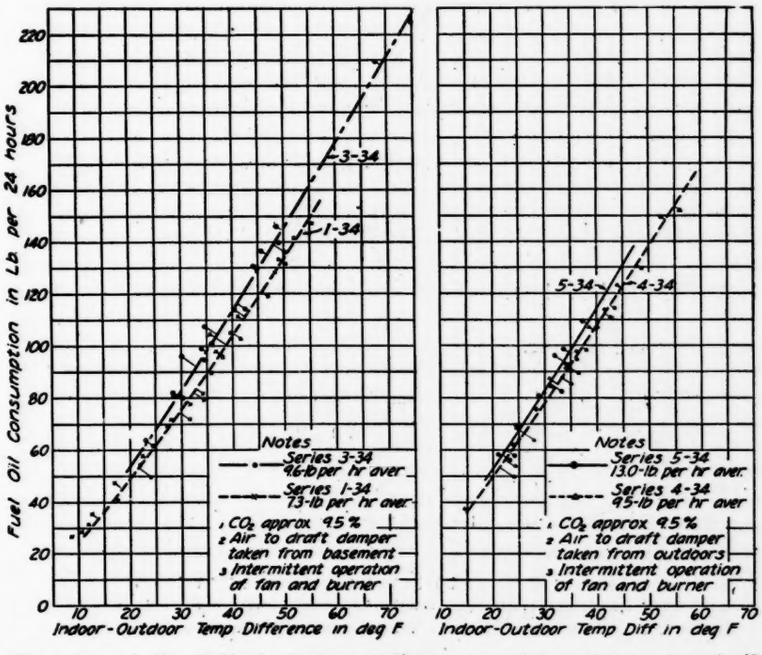
During the heating season of 1935-1936 the furnace used was of steel construction especially designed for oil burning. This furnace will be referred to hereafter as the oil-burning furnace. The burner was the same gun-type oil burner which was used in the conversion unit. Hence, any differences in performance of the two furnace installations could be attributed to the differences in the furnace and not to the differences in the type of oil burner used.

The fuel oil burned was of a No. 3 grade furnace oil having a specific gravity of approximately 36 deg. Baume and a heating value of approximately 19,750 B.t.u. per lb.

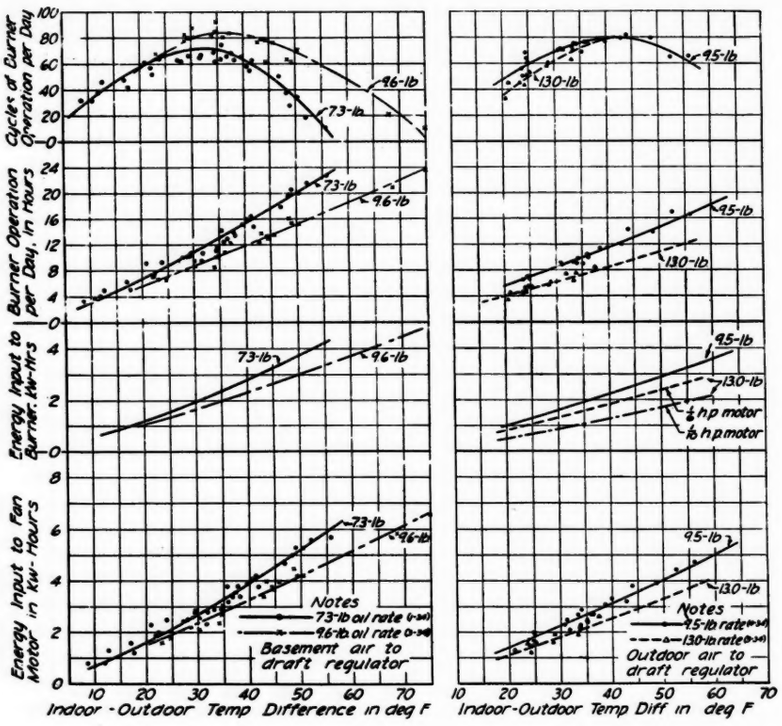
The control of the heating plant was accomplished by means of a room thermostat operating to start and stop the oil burner and the circulating fan. This room thermostat was used in conjunction with two bonnet thermostats, one of the latter operated to stop the burner when the bonnet temperature exceeded a predetermined value, and the other operated to stop the fan when the bonnet temperature became less than a predetermined value.

Two Test Methods Used

Tests Under Continuous Operation—In order to determine the capacity at the bonnet and the thermal efficiency of the furnaces for various conditions of operation, tests were made under conditions of thermal equilibrium with both the furnace and the fan operat-


Fuel Oil Consumption in Lb per 24 hours
3-34
1-34
5-34
4-34
Notes
Series 3-34 46-lb per hr aver
Series 1-34 73-lb per hr aver
1. CO_2 approx 95%
2. Air to draft damper taken from basement
3. Intermittent operation of fan and burner
Series 5-34 130-lb per hr aver
Series 4-34 95-lb per hr aver
2. Air to draft damper taken from outdoors
Indoor-Outdoor Temp Difference in deg F
Indoor-Outdoor Temp Diff in deg F

Figs. 4a and 4b. Daily fuel consumption curves for various rates of oil input into conversion oil furnace with forced air heating system. Season 1934-35.



Figs. 5a. and 5b. Performance data for burner and fan operation in Research Residence. Conversion oil furnace with forced air heating system. Season 1934-35.

ing continuously. In these tests, the temperature of the inlet air was maintained at approximately 70F, and the quantity of circulating air, the rate of oil input, the draft in the combustion chamber, and the amount of air required for combustion were maintained at predetermined values during the 2-hr. test period. These tests, which corresponded to the usual laboratory tests for the determination of the heat output of a heating unit, provided data for the heating unit only, without reference to the structure in which it was placed.

Tests Under Service Conditions—The tests made under service conditions differed from the tests made under continuous operation in that the operation of the burner and fan was automatically controlled to maintain a temperature of 71F in all the rooms of the house rather than to maintain a constant capacity at the furnace bonnet. Therefore, in these tests the operation of the burner and fan was intermittent in character and not continuous, and the test periods were 24 hr. in length instead of 2 hr.

Tests Under Continuous Operation

Variations in Air Quantity—The results obtained from the conversion unit are shown in Fig. 1. For these tests, the CO_2 in the flue gas was maintained constant at a value of 9.5%, and the effect of varying the quantity of air circulated over the heating surfaces of the furnace was studied. The results shown are typical and are similar in nature to those obtained from tests on the oil-burning furnace installation made under similar conditions of operation. The full lines in Fig. 1 represent results obtained with constant rates of oil input to the furnace. For a given rate of oil input, both the capacity and efficiency of the furnace increased as the quantity of air circulated over the heating surfaces was increased. For example, at a 9.66-lb. oil input rate, the capacity was increased from 120,000 B.t.u. per hr. to 140,000 B.t.u. per hr. when the air quantity was increased from approximately 1380 c.f.m. to 2240 c.f.m. This represented an increase in capacity of approximately 17% for an increase in air quantity of approximately 62%. The corresponding increase in bonnet efficiency under these conditions was from 63% to 74%.

It may also be noted from Fig. 1 that the increase in capacity for a given increase in air quantity became smaller as the air quantity was increased. For example, an increase in air quantity from 1400 c.f.m. to 1600 c.f.m. resulted in an increase in capacity of 6500 B.t.u. per hr.; whereas an increase in air quantity from 2000 c.f.m. to 2200 c.f.m. resulted in an increase in capacity of only 2500 B.t.u. per hr. It is apparent from these tests that in order to facilitate the transfer of heat from the heated surfaces to the circulating air, an adequate circulation of air over the heating surfaces should be provided.

Variations in Oil Input Rate—The performance curves in Fig. 1 show also that for a constant quantity of air circulated, the capacity and efficiency of the furnace are dependent upon the rate of oil input to the burner. In order to show more clearly the relationship between oil input and capacity, the values for an air quantity of 1675 c.f.m. shown in Fig. 1 have been plotted in Fig. 2. Similar curves for the oil-burning unit are also given. The broken lines represent results obtained with the conversion unit, and the full lines represent results obtained with the oil-burning furnace.

In any given furnace installation, in which a constant

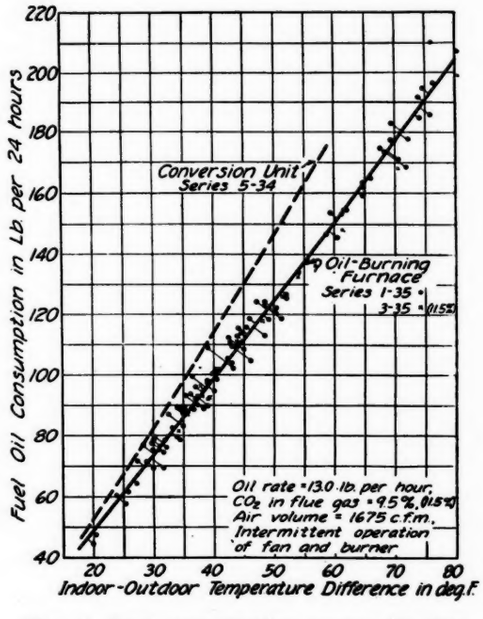

Fuel Oil Consumption in Lb per 24 hours
Conversion Unit Series 5-34
Oil-Burning Furnace Series 1-35 • 3-35
Oil rate = 13.0 lb. per hour.
CO₂ in flue gas = 9.5%
Air volume = 1675 c.f.m.
Intermittent operation of fan and burner.
Indoor-Outdoor Temperature Difference in deg F

Fig. 6. Fuel consumption curves for two oil furnaces.

value of CO_2 was being maintained, an increase in the amount of heat release in the furnace resulted in higher temperatures of the flue gas and hence in larger flue gas losses per pound of fuel. This condition is reflected in the efficiency curves of Fig. 2, from which it may be observed that the furnace efficiency decreased as the rate of heat release was increased. The tests made under actual service conditions, which are discussed in a later section, also tended to confirm the conclusion that the most economical utilization of fuel in a given installation would be obtained with small rates of heat release in the furnace.

A comparison of the results from the conversion unit and oil-burning furnace, as shown in Fig. 2, indicated that, for a given rate of heat release in the furnace, the greater amount of heating surface of the oil-burning unit resulted in a greater amount of heat being transmitted from the furnace gases and absorbed by the air circulated. This conclusion was also confirmed by the tests made under actual service conditions.

The efficiency curves in Fig. 2 also show that for a furnace having a given amount of heating surface the best rate of oil input as defined by the heat release occurs at a value too low to be used as a practical basis for the design of oil-burning furnaces.

Variation in CO_2 in Flue Gas—The performance curves in Fig. 3 indicate that for a constant quantity of air circulated and a fixed rate of oil input to the furnace, the capacity and efficiency of the heating unit were also affected by the combustion characteristics, as indicated by the percentage of CO_2 in the flue gas. Adjustments in the fuel-air ratio were made by means of the adjustable opening in the air inlet to the burner, and variations in the CO_2 content in the flue gas from 5½% to 11½% could be obtained. In no case was there any indication of incomplete combustion of the fuel.

The increase in capacity and efficiency brought about by an increase in the CO_2 content in the flue gas was not marked. For each increase in the CO_2 content of 1%, there was obtained an increase in bonnet efficiency of approximately 1%. However, it should be recognized that these results were obtained with a furnace in which the temperature of the flue gas at the outlet of the radiator was quite low and did not exceed approximately 500F. In the case of furnaces which are not provided with sufficient effective heating surface, and which are fired at such a high rate of oil input that the temperature of the flue gas at the outlet exceeds approximately 500F, any increase in the CO_2 content of the flue gas will be accompanied by much larger increases in furnace efficiency.

Tests Under Actual Service Conditions

Variation in Rate of Oil Input—An extensive series of tests was conducted with a wide range of oil input rates that ranged from a minimum of 7.3 lb. per hr. to a maximum of 13.0 lb. per hr. The heat supplied by the furnace when the burner was adjusted to maintain a 7.3 lb. oil rate was not quite sufficient to offset the heat loss from the house during zero degree weather, but was sufficient to supply the heat required during average weather conditions. The heat supplied by the furnace when the 13.0 lb. rate was maintained was adequate to heat the house during the most severe weather conditions.

The weight of fuel oil required for a 24-hr. period to maintain the temperature of the house at 71F was plotted against the difference in temperature between indoors and outdoors, as shown in Figs. 4a and 4b. The curves presented in Fig. 4a are for two rates of oil input, 7.3 lb. and 9.6 lb. per hr.; while the curves presented in Fig. 4b are for rates of 9.5 lb. and 13.0 lb. per hr. The curves show that when a constant value of CO_2 in the flue gas was maintained, the fuel consumption increased as the rate of oil input was increased. The increase in this case was of the order of 6%. This indicates that the operation of the burner for relatively short periods, during which a high rate of combustion was maintained, was not as conducive towards fuel economy as the operation of the burner for longer periods, during which a lower rate of combustion was maintained. In the former case the flue losses during the periods of burner operation, and also the losses due to the heat carried up the chimney during the off-periods of the burner, were greater than in the latter case on account of the higher temperatures of the flue gas. These statements would have to be modified, however, if there are any cases in which conditions might arise whereby the combustion process can be maintained better with high rates of oil input than with low rates.

The changes in the rate of oil input to the furnace were also reflected in the operation of the fan and burner units in the forced-air heating system, as shown by the data in Figs. 5a and 5b. The top set of curves in these graphs shows, for the same series of tests whose results were shown in Figs. 4a and 4b, the frequency of burner operation as represented by the number of cycles per 24 hr. For a given rate of oil input it may be noted that in mild weather the frequency of operation of the burner increased as the temperature difference between indoors and outdoors increased. For larger values of temperature differences the burner continued in operation for longer periods and the frequency of the operating periods decreased. Finally, when the outdoor weather conditions were such that the heat developed in the furnace was just sufficient to offset the heat loss from the house, the burner operated continuously and the number of cycles per 24 hr. became unity.

It may be noted from the second set of curves in Figs. 5a and 5b that the increase in the total time of operation of the burner was practically proportional to the increase in temperature difference between indoors and outdoors. Also, for a given outdoor temperature condition an increase in the rate of oil input was accompanied by a decrease in the total time of burner operation. Furthermore, the decrease in the total time of burner operation was in turn accompanied by a decrease in the electrical energy input to the burner motor, as shown by the third set of curves. It may be observed that the substitution of a more efficient motor on the burner unit resulted in more economical use of electric current. It is also apparent that the electrical input to the burner motor, which included the energy required for the spark ignition process, was sufficiently large to be considered as an important item in determining the

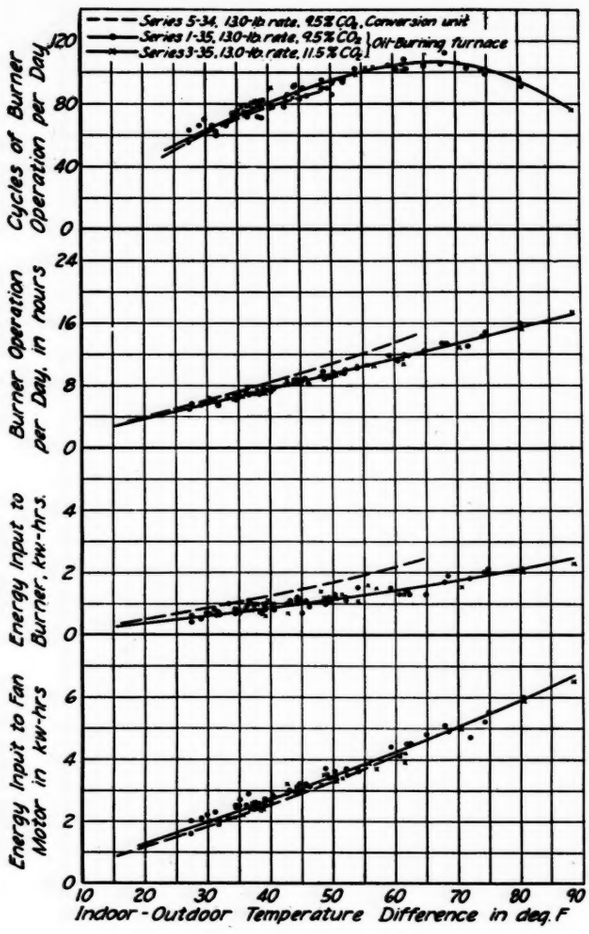

Series 5-34, 13.0-lb rate, 9.5% CO_2, Conversion unit
Series 1-35, 13.0-lb rate, 9.5% CO_2 } Oil-Burning Furnace
Series 3-35, 13.0-lb rate, 11.5% CO_2
Cycles of Burner Operation per Day
Burner Operation per Day, in hours
Energy Input to Burner, kw-hrs.
Energy Input to Fan Motor in kw-hrs
Indoor-Outdoor Temperature Difference in deg. F

Fig. 7. Performance data for burner and fan operation in Research Residence, oil furnace, forced air heating system. Season 1935-36.

overall cost of operation of the heating system plant.

With the method of thermostatic control used in these tests, the times at which the fan operated practically coincided with the times at which the burner operated, or the frequency of operation was nearly the same for both fan and burner. The total time of fan operation was in most cases slightly greater than the total time of burner operation, but the differences were so small that for all practical purposes the data presented in the second set of curves in Figs. 5a and 5b apply equally well to the fan and the burner. The electrical input to the fan motor was smaller for the higher rates of oil input.

Comparison of Conversion and Oil-Burning Units—The tests which were made to determine the comparative performance characteristics of the conversion unit and the oil-burning furnace under actual service conditions were conducted under identical conditions of operation. The results obtained for an oil input rate of 13.0 lb. per hr. with the conversion unit were presented in Figs. 4b and 5b and have been transferred to Figs. 6 and 7 for purposes of comparison with the results obtained with the oil-burning furnace. The curves representing the results for the latter furnace are shown as full lines.

The fuel consumption curves show in Fig. 6 that the fuel requirements, for a day in which the indoor-outdoor temperature difference was 33F, were 94 lb. for the conversion unit and 82.5 lb. for the oil-burning furnace. Thus the fuel requirements for an average day were approximately 14% greater for the conversion unit than they were for the oil-burning furnace. For an indoor-outdoor temperature difference of 55F the difference was greater, and amounted to approximately 19%.

Slight differences in operating characteristics were also obtained, as are shown by the curves in Fig. 7, for burner cycles, burner operation, burner motor input, and fan motor input. Very little difference may be observed in the number of cycles of burner operation per day for the two installations. However, both the number of hours of burner operation and the electrical energy input to the burner motor were greater for the conversion unit than for the oil-burning furnace. This could be accounted for by the fact that, although the rate of oil input was the same in the two installations, the total fuel consumption was greater for the conversion unit than for the oil-burning furnace and hence the hours of burner operation were also greater.

It may be observed that, although the total time of fan operation per day was approximately 12% less for the oil-burning furnace than for the conversion unit, the total electrical input to the fan was approximately 8% greater. This difference can be accounted for by the fact that, due to the greater resistance to air flow in the case of the oil-burning furnace and also due to slight differences in motor characteristics, the rate of electrical input to the fan motor for the oil-burning furnace was approximately 25% greater than that to the fan motor for the conversion unit.

For a day in which the temperature difference between indoors and outdoors was 33F, the combined electrical energy inputs to the fan and burner motors were 3.1 kw-hr. for the conversion unit and 2.9 kw-hr. for the oil-burning furnace, or a net difference of 0.2 kw-hr. per day. The difference was greater for days having greater heat demand. The operation of the oil-burning furnace resulted, therefore, in a net reduction in fuel oil of 11.5 lb. and a net reduction in electrical energy of 0.2 kw-hr. per day. Based on unit costs of 7 cents per gallon for fuel oil and 3.1 cents per kw-hr. for electrical energy, these reductions were equivalent to 10.9 cents per day for fuel and 0.6 cents per day for electrical energy, or a total of 11.5 cents per day. For an average heating season consisting of 210 days this is equivalent to a difference in net operating costs of approximately $24. It may be concluded from these tests that under identical conditions of operation, the best economy was secured with the furnace which was equipped with ample heating surface and which was designed specifically for oil burning.

Variations in CO_2 in Flue Gas—In order to determine the operating characteristics of the oil-burning furnace when the fuel was burned under the best attainable combustion conditions, the air inlet to the burner was adjusted until a value of 11.5% CO_2 in the flue gas was obtained. It was not possible to increase the CO_2 content much beyond this value without obtaining some indication of unburned combustibles. Otherwise, the operating conditions were maintained the same as in the previous tests; namely, with 1675 c.f.m. air circulated,

13.0 lb. oil rate, and 0.02 in. draft in the combustion chamber. The results obtained from this test are shown in Figs. 6 and 7 in which the points are designated as belonging to Series 3-35. In general, no appreciable difference, either in fuel consumption or plant operation, was obtained when the CO_2 content in the flue gas was increased from 9.5% to 11.5%. However, when the heat demands of the house were large, there was a slight tendency towards an improvement in conditions with the higher CO_2 content. These results are in substantial agreement with those obtained from the tests made under conditions of continuous operation, as shown in Fig. 3. For example, for an oil input rate of 12.84 lb. per hr., the increase in bonnet efficiency was approximately 1.5% when the CO_2 content was increased from 9.5% to 11.5%. For all practical purposes the results obtained with the two conditions of combustion may be regarded as identical.

These results serve to emphasize that an oil-burning furnace which is provided with sufficient effective heating surface should perform satisfactorily notwithstanding fairly wide deviations in the CO_2 content of the flue gas.

Overall House Efficiency—In order to compare the fuel consumptions with oil and anthracite, the fuel quantities shown in Fig. 6 were reduced to terms of heat input to the furnace, in millions of B.t.u per 24 hr., and were plotted as shown in Fig. 8. The results for the conversion unit (Curve No. 1) and for the oil-burning furnace (Curve No. 2) were obtained with an oil input rate of 13.0 lb. per hr., a combustion condition of 9.5% CO_2 and an air circulation of 1675 c.f.m. It should be noted that these tests were based on intermittent operation of the fan and oil burner, whereas the tests on the hand-fired coal furnace (Curve No. 3) were based on the maintenance of continuous combustion under which conditions the automatic controls varied the combustion rate so that it approximately corresponded with the heating demands of the house. In all three cases the operation of the heating plant was controlled by means of sensitive thermostatic controls.

For the same weather conditions, the values of the heat input were less and the values of the overall house efficiency were greater for anthracite than for oil. The most obvious explanation for this difference is that the combustion efficiency for oil combustion was considerably less than that for anthracite. This most obvious explanation, however, was not satisfactory since there was no reason to believe that a material difference existed either in the combustion efficiency, or that the flue gas losses were greater in the one case than in the other. In order to make an independent analysis of the factors affecting the utilization of heat by the furnace, the weight of the products of combustion and the flue gas losses were calculated from the flue gas analyses and the temperatures of the flue gas, observations of which were made under conditions of continuous operation of the burner and fan. These results are shown in Fig. 9a plotted against the heat input to the furnace.

The flue loss for any fuel may be considered as a composite value which is dependent on both the temperature and the weight of the flue gas. A comparison of the curves representing flue gas temperature in Fig. 9a shows that the flue gas temperatures were lower for oil, when it was burned in the oil burning furnace, than for anthracite. This indicates that the flue gas temperature alone is not a reliable index of combustion efficiency when comparing different fuels. The products of combustion may be considered as being composed of dry gas and water vapor. The curves in Fig. 9a indicate that the weight of the dry gas was approximately the same for oil and for anthracite, but that the weight of water vapor was greater for oil than for anthracite, principally on account of the greater percentage of hydrogen in the former fuel.

The combined effect of the flue gas temperature and the weight of flue gas determined the flue gas loss for various rates of heat input to the furnace. In this connection it may be observed, that it would be possible to still further reduce the flue gas temperatures by the addition of effective heating surface to the furnace. This would result in a smaller flue gas loss for all combustion rates, and hence in an increased efficiency. As indicated by the top set of curves in Fig. 9a, the flue gas loss for a given value of heat input was approximately the same for oil (oil-burning furnace) and for anthracite. In other words, the combustion efficiencies in the two cases were approximately the same. Hence, some explanation involving factors in addition to combustion efficiency must be sought to account for the differences obtained in the heat input for a given difference in temperature between indoors and outdoors.

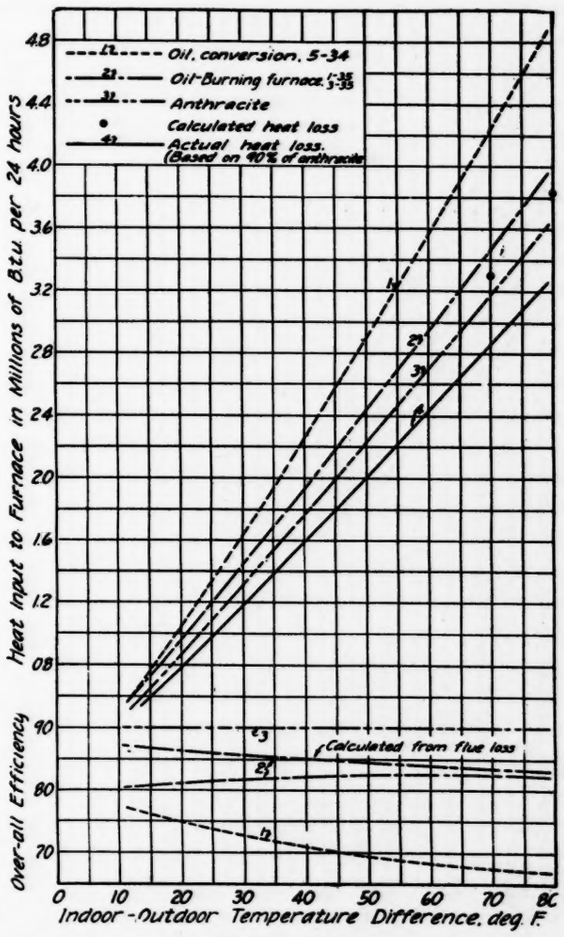
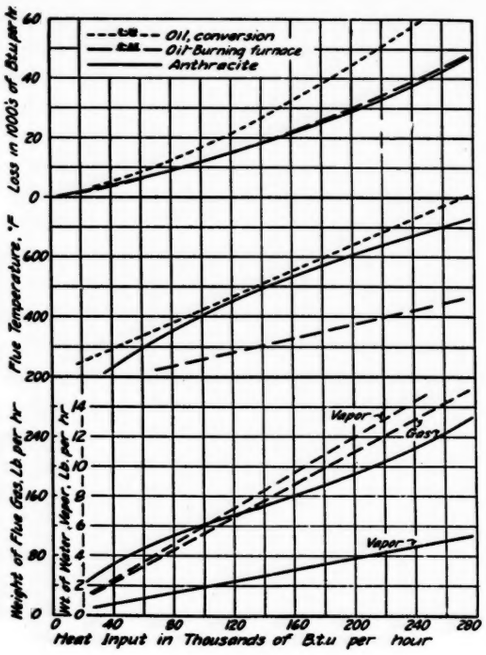

Oil, conversion, 5-34
Oil-Burning furnace, 5-35
Anthracite
Calculated heat loss
Actual heat loss. (Based on 90% of anthracite)
Heat Input to Furnace in Millions of Btu per 24 hours
Over-all Efficiency
Calculated from flue loss
Indoor - Outdoor Temperature Difference, deg. F.

Fig. 8. Heat input to Research Residence.



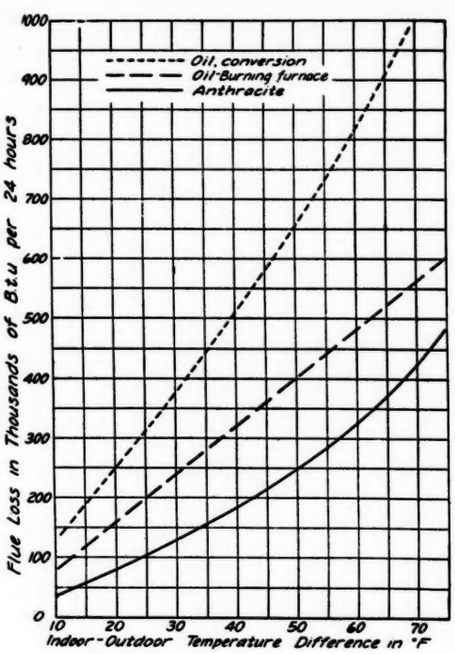


Fig. 9a. (Left) Analysis of flue gas losses. Fig. 9b. (Right) Calculated total flue loss.

In the case of anthracite, the automatic control varied the rate of combustion so that it approximately corresponded with the heating demands of the house; namely with the difference in temperature between indoors and outdoors. Hence the combustion efficiency, as determined by the rate of combustion and therefore the heat input to the furnace, would be directly reflected in the curves of heat input to the house, Fig. 8, which are based on the temperature difference between indoors and outdoors.

However, in the case of oil, the rate of oil input, or the hourly heat release, was constant for all weather conditions, and control was obtained by adjustments in the length of time that the burner was allowed to operate. Therefore, the combustion efficiency would be dependent on this rate of heat release and not on the temperature difference between indoors and outdoors. Furthermore, the net flue gas loss for a 24-hr. period, during which the burner was operated intermittently, would be determined not only by the combustion efficiency but also by the total length of time during which the burner was actually in operation. The oil burner was so adjusted that the hourly heat release was somewhat greater than the hourly heat loss from the house on the maximum day. The hourly heat release in the case of anthracite, however, was just sufficient to offset the hourly heat loss from the house. Hence even on the maximum day the hourly heat release in the case of the oil-burning furnace was greater than that for anthracite, and the curves in Fig. 9a show that, although the combustion efficiencies for the oil-burning furnace and the anthracite were the same at the same heat release, during the actual periods of operation the flue gas loss was greater and therefore the combustion efficiency was less for the oil-burning furnace than it was for the anthracite. Since the rate of oil input remained the same for all weather conditions it is therefore evident that the oil-burning furnace always operated at a less combustion efficiency than the anthracite during the periods of actual operation. The net flue gas loss during a 24-hr. period would be determined by the product of the hourly flue gas loss during the actual operating period and the total hours of burner operation during the day. The calculated values of net flue gas loss shown in Fig. 9b were derived from the data presented in Fig. 9a and are consistent with the experimental data for the heat inputs shown in Fig. 8 in that the curves representing higher flue gas losses in Fig. 9 correspond in position with those representing the higher heat inputs in Fig. 8. It is the total amount of the net flue gas loss over a given period of time rather than the combustion efficiency alone, that determines the relative position of the curves of heat input shown in Fig. 8.

This analysis of the factors affecting the net flue gas loss indicates that in order to secure minimum flue gas losses from an oil burner, the flue gas temperatures and the weight of the products of combustion should be maintained at a minimum value. This condition can be most nearly approached by adjusting the rate of oil input so that the heat release just offsets the heat loss from the house in the most severe weather. This analysis also suggests that if the rate of oil combustion could be varied to conform at all times with the heating demands of the house, an overall house efficiency equal to that obtained with anthracite should be possible of attainment. Since the combustion efficiency is affected by the amount and location of the heating surfaces, the necessity of providing adequate and effective heating surface is apparent.

Bureau of Mines Reports on School Disaster; Urges Central Heating Plants in Isolated Structures

A SUMMARIZATION of the conclusions of specialists of the United States Bureau of Mines detailed to investigate the cause of the disastrous explosion at the New London, Texas, Consolidated School Building on March 18, which resulted in the death of 455 persons, was given in a letter addressed to Governor James V. Allred of Texas, by Acting Secretary of the Interior, Charles West. The recommendations of the Bureau of Mines experts as to precautionary measures to be taken in the future were also incorporated in the letter, which follows:

April 13, 1937.

Hon. James V. Allred,
Governor of Texas,
Austin, Texas.

My dear Governor Allred:

The duties of the United States Bureau of Mines, Department of the Interior include investigations of causes of gas and dust explosions and issuance of recommendations that will aid in preventing their recurrence. Accordingly, four experienced specialists of the Bureau's staff were assigned to a study of conditions relating to the deeply regretted disaster at the New London, Texas, Consolidated School Building on March 18, 1937. These men reached the scene of the explosion on March 19, started their studies on March 20, and continued them through March 27.

The Bureau's representatives were D. J. Parker, Salt Lake City, Utah, a mining engineer with years of experience in the investigation of gas and dust explosions not only in and around mines but also in surface structures; G. W. Jones, Pittsburgh, Pa., a recognized authority on the theory of gas explosibility who has had wide experience in the investigation of explosions in sewers and in other enclosed spaces; and H. B. Hill and Gustav Wade of the Bureau's Petroleum Field Office at Dallas, Texas, both of whom are thoroughly familiar with the behavior of petroleum and natural gas and the technique of their proper handling.

Although their final report has not been completed, these specialists have sent their conclusions and recommendations to the Director of the Bureau of Mines, and in turn, the Department is pleased to offer them to you. We hope that the following resume of the Bureau's findings may be of value to the people of Texas and to the whole country in efforts to prevent catastrophes of the kind that took place at New London:

(1) The immediate cause of the disaster was an explosion of a gas-air mixture, resulting from an accumulation of natural gas in an unventilated space beneath the first floor of the main school building. This space extended along the west front of the building and had a volume of approximately 46,000 cubic feet. The physical evidence shows that the source of ignition was near the north end of this chamber and that the explosion propagated in a southerly direction.

(2) The manipulation of an electric switch in the manual training room near a door leading into the unventilated region ignited the gas.

(3) The gas was present because of leakage from gas lines and their fittings suspended beneath the floor, with virtually no method of detecting the gas or of removing it by natural or forced ventilation.

(4) The gas did not seep through the soil; this fact was determined fully by evidence secured from 71 test holes that were drilled to the rock below the surface formation. Numerous tests were made of the atmosphere in the holes by means of detectors for inflammable gas.

(5) The great violence of the explosion probably was due to the existence of a large volume (possibly as much as 46,000 cubic feet) of an explosive mixture of gas and air together with the fact that the ignited gas was in an enclosed and substantially confined space with little or no opportunity for expansion at low pressure. Hence maximum opportunity was afforded to build up a high pressure as the explosion wave progressed, resulting in wide-spread disrupting and destructive effect.

(6) The results would have been the same under identical conditions regardless of the composition of natural gas used.

The following recommendations have been made by specialists of the Bureau of Mines who have studied the evidence of the New London disaster:

(1) Public buildings should not have unventilated, relatively inaccessible, enclosed spaces, especially in the basement region.

(2) Basements, attics, and all spaces below floors, steps, and similar places in public buildings or buildings in which the public assembles should be provided with adequate, constantly functioning ventilation.

(3) All gas and electrical lines serving public buildings and other buildings where the public assembles, and all piping, connections, fixtures, appurtenances, and appliances in such buildings, should be of permanent construction, placed by competent persons in accordance with the latest approved fire underwriters' or other applicable specifications, and operated in accordance with known safe practices; also, they should be kept in repair at all times.

(4) Responsibility for the construction. maintenance, and operation of gas pipe lines serving the public, and especially for the regulation of pressures in such lines, should be exclusively under the control of persons or organizations experienced in such work. Responsibility for the testing, lighting, and general care of the entire heating system should be entrusted only to persons who are familiar with such systems and competent to handle them safely and efficiently.

(5) Advantages in safety may be gained by placing gas mains or headers outside of buildings (especially public buildings and buildings where the public assembles); thereby minimizing the hazard of gas leak-

age in enclosed spaces. In some instances weather conditions, architectural design, or possibilities of aggravated corrosion may make such construction inadvisable. However, a desirable objective is to reduce to a minimum the enclosed piping for fuel purposes within a public building. The explosion in the New London School probably would not have occurred if the individual connections to the header had been made outside the building and the service lines brought into the building through risers from the header.

(6) Although the Bureau's tests proved that the explosion at the New London school was attributable in no way to seepage of gas through the soil, experience of the Bureau of Mines with other explosions indicates that gas may enter basements and other enclosed spaces that are partly underground. This possible hazard may be present especially where sub-surface conditions permit gas to travel laterally through the soil along pipes that enter buildings below the ground surface. Accordingly provision should be made to seal all openings where pipes pass through walls.

(7) Central heating systems, with the heating plant isolated in a separate structure, have definite advantages with respect to protection against fire, explosion, and carbon monoxide. They also have certain advantages in efficiency with respect to large public buildings.

(8) Suitable warning agents with distinct odors, introduced into fuel gases that have little or no odor of their own, have proved to be of great aid in detecting leaks in public buildings and private homes. Even though the teachers and pupils of the New London school were accustomed to odors of gas and oil from the oil field in which they lived, it is likely that a malodorant in the gas used at the school would have given enough advance warning to prevent the explosion. Although use of malodorants is only one factor to be considered (as explosions have occurred with mixtures of air and manufactured gas which has a distinct odor) study should be made of fuel-service installations with the view of determining the need for impregnating the gas with a warning agent that will enable users of the gas to detect leakage. Warning devices based on instruments that will detect presence of inflammable gas and give an alarm also are to be considered, but obviously if such systems are to be effective they must be maintained carefully and tested frequently.

(9) There is need for a State supervisory body to inspect structures and buildings in which the public assembles lying outside the corporate limits of cities and towns where municipal safety inspection is in effect.

(10) Careful inspection by State or municipal agencies should extend not only to the construction of public buildings or buildings in which the public assembles but also to plans and design of such buildings. This safety inspection should include structural features as well as the details of heating and ventilation.

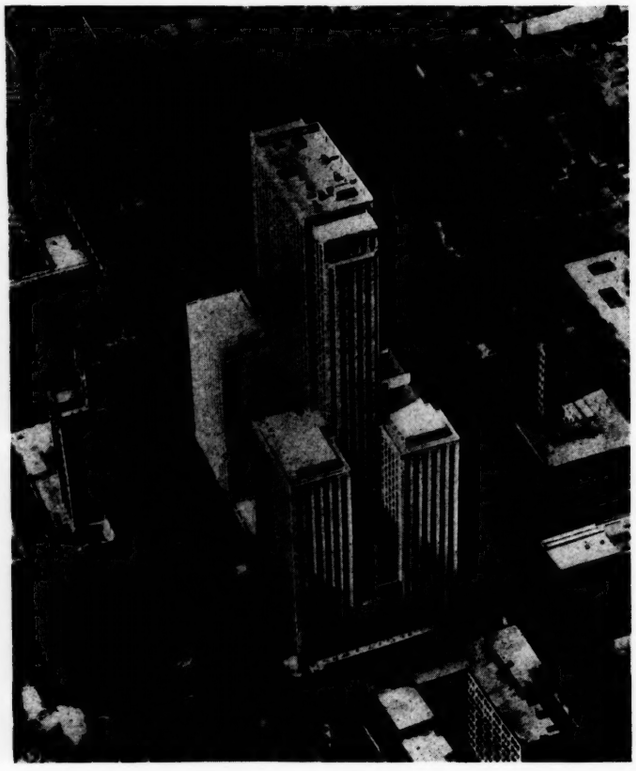
The use of warning agents for odorizing gas was developed in research by the Bureau of Mines. If you should desire information on this subject, the Department will be pleased to detail technical personnel experienced in this field to cooperate with you. The Department also offers other facilities that may be available for increasing safety to life and property within the State of Texas.

Sincerely yours,

CHARLES WEST,

Acting Secretary of the Interior.

Cleaning Air with Electricity



CLEAN air will be supplied this summer to the Field Building, one of Chicago's newest and most modern office buildings. Already air conditioned to the extent of temperature and humidity control, the lower arcade and first four floors of this 45-story building will approach the ideal with the installation of electrostatic air cleaners.

The air cleaning equipment will have a capacity of 272,700 c.f.m. of air and an expected efficiency of over 99% of weight of particles removed from the air. Operating on an electrostatic principle the air cleaner is said to remove microscopic particles as small as one-fifth micron in size; to operate on a small current consumption of 10 kw. and a minimum of maintenance.

The air cleaning equipment will consist of 18 units ranging in capacity from 33,000 c.f.m. to 3000 c.f.m., employing a total of 369 collector cells and 185 ionizing assemblies. The first of the units was placed in operation on May 1, and the installation is expected to be completed during July.

(Left) The Field Building is one of Chicago's newest and most modern office buildings. Electric air cleaning equipment is now being installed to supply clean air for four of the 45 floors.

EDITORIALS

The Consumer Angle

Recent appearance of a Government marketing report based on the 1934 Real Property Inventory calls to mind again the well established fact that there are still about 40% of the city dwelling units in the whole country which do not have central heating. This fact has so often been noted on the pages of this magazine that it seems unbelievable that there are still many of our readers who do not know and appreciate it. The statement is constantly heard that this represents a great unsold potential market. Doubtless it does. What we would like to know, however, is why it is that if this potential is really good, all the sales effort directed at it has not made more of an impression. There is almost no information on this point which can be accepted without serious question. What information there is points toward a variety of reasons including high cost of equipment and installation, poorly directed sales efforts, aiming too high to hit the mark, and various others. In our estimation much of the reason is to be found in the fact that a great deal of the equipment offered is not specifically designed to appeal to this potential market. We should know more about the real facts as to what the users of stoves and fireplaces think about the whole problem, and more about what they are able to pay.

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This Month's Meetings

This year the season for conventions and meetings is earlier than usual. Several of the organizations which commonly hold their meetings in June have pushed their dates forward to May. Meetings are spread over the month with the Heating, Piping and Air Conditioning Contractors National Association meeting at Minneapolis, May 17 to 19, the ASRE meeting at French Lick on May 25 to 27, and the NDHA annual convention at Detroit on the 25th to 28th. Interesting programs have been arranged in each case.

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Voluntary Fair Practice Codes

Ever since the NRA codes were terminated so suddenly by court action there has been a persistent feeling that something should be devised to take their place. Public and private discussions have gone on, but concrete plans have come forward but slowly. Early this year a fair competition code was agreed upon between the organized heating contractors and a plumbing and steamfitting labor union in New York City and Nassau and Suffolk Counties in New York state. The code includes a statement of what are considered unfair trade practices and contains many of the features of the old NRA codes. A bid depository is in operation. The present codes differ from the NRA codes in that enforcement is through the voluntary efforts of the agreeing parties and not through Government pressure.

It seems to us that this movement should be watched with interest. There is no doubt but that a future policy on such matters as fair competition practices and wage and hour provisions is in process of formation. The chief questions are how and when the policy will emerge. Both will undoubtedly be affected by the degree of success which is achieved by the voluntary codes now appearing here and there and of which the New York code is an example. A large measure of success for them will tend to form a pattern for a general policy; distinct failure will leave the door wide open and no one can foretell what the ultimate policy may be like.

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Fewer Fuel Oil Grades

For some time there has been discussion among leaders in the oil refining industry as to whether the time has come to reduce the number of grades of domestic fuel oil from four to two. The fact is that much of the consumption is already confined to two grades. How soon practical considerations will permit a contraction of fuel oil to two grades is hard to foretell. It seems certain though that two properly standardized and carefully controlled grades of domestic heating oil will be aimed at by the refiners at the earliest opportunity, for such a practice would have many desirable features from their point of view. Much, too, can be said in favor of narrowing the range of available fuel oils so far as equipment manufacturer and user are concerned.

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Buildings Without Windows

Buildings without the traditional form and style of windows are not exactly innovations but they are still rare enough to have news value and consequently each time one is erected it has had attention directed to it. Of late years the tendency toward either omitting windows fitted into the side wall materials or else toward sealing their cracks against air leakage has been increased with the growth of year-round air conditioning. So also has the appearance on the market of transparent block building materials suitable for substitution for opaque clay brick and stone in the side walls affected the use of the traditional window. With provision made for bringing in light elsewhere than through the window opening and with air channels other than the window provided, about the only remaining utilitarian purpose of the windows is that of permitting occupants to look out. In some classes of buildings, such as detached residences, this consideration is important. In others it is of no importance at all and the traditional window has little left to commend it. There is every reason to believe that air conditioning will continue to exert a decided influence on the question of whether there are to be windows and if so what form they will take.

ABSTRACTS of Current Papers, Books and Pamphlets

Principles of Economical Heating

The third edition of this well known pamphlet on economical heating, prepared by the National District Heating Association to assist building owners and managers, has been considerably enlarged and brought up to date. Previous editions have been widely circulated and have been a great influence towards reducing building heating costs.

The pamphlet describes the need for and the method of controlling steam in building heating systems in order that the amount of heat supplied in mild weather shall not exceed the amount actually required. It also discusses methods of reducing the fixed and variable heat losses from a building. While many of the principles set forth are more effective when applied to heating systems served by district steam, a large number are applicable to heating systems regardless of the source of supply. Among the subjects covered are: general rules for economical heating; heat losses from buildings; short-hour heating; temperature or heat control; methods of heat regulation; methods of making savings in heating systems; common faults and corrections, and control equipment.

[*"Principles of Economical Heating," published by the National District Heating Association in collaboration with the National Association of Building Owners and Managers. Obtainable from the National District Heating Association, Engineers Club Building, 1317 Spruce St., Philadelphia, Pa. Heavy paper cover; 6 x 9 in.; 60 pages; price, 25c.*]

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Determining the Rate of Flow in Pipes

A number of tests were made by the author of this bulletin for the purpose of obtaining information concerning the feasibility of using an elbow in a pipe line as a means of measuring the flow of fluid through the pipe. The idea was to measure the difference between the pressures of the fluid on the inside and the outside curves of the elbow, respectively. The tests reported were made on threaded and flanged elbows of long and short radii, ranging in diameter from 1 in. to 24 in. Sixteen different elbows were tested in nearly forty different positions and locations in various pipe lines. All the elbows tested were 90° bends, and water was the only fluid used in the tests. As a result of the investigation the conclusion was reached that the ordinary commercial 90° elbow may be used successfully as a flow meter. Above a certain minimum velocity, usually 1.5 to 2.0 f.p.s., a constant ratio exists between the difference between the pressure heads at the inside and outside curves of an elbow and the velocity head of the water passing through the pipe. For accurate results the value of this ratio for any elbow meter should be found by calibrating the meter in the actual service location. For cases where this cannot be done, the bulletin presents curves from which it is possible to select a value of the ratio that should enable the discharge to be calculated in any ordinary case with an error of less than 10%.

[*"The Use of an Elbow in a Pipe Line for Determining the Rate of Flow in the Pipe," by Wallace M. Lansford. Published by the Engineering Experiment Station, University of Illinois, Urbana, Ill. Bulletin No. 289; paper cover; 6 x 9 in.; 36 pages; copies available free until September 15, 1937, or until supply is exhausted, after that the price will be 40c.*]

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The Construction Industry, 1935

The amount of work performed by the 75,047 contracting establishments in the United States in 1935 aggregated $1,622,862,000, according to the first of three volumes dealing with the construction industry. This was a year for which the value of construction was small in comparison with that for many of the earlier years, according to the Census Bureau, publisher of the book.

The Bureau points out that the figure for work performed is not directly comparable with the figures reported by private organizations for the dollar value of contracts awarded, because of the differences in scope and content between the figures for work performed and those for contracts awarded. The Census figure for work performed represents all of the work reported by contracting establishments, whereas the figures of the private organizations for contracts awarded are based on reports for individual projects, and do not include projects below certain established minimum values. From this standpoint, the figures for contracts awarded, the Bureau states, would be lower than the ones for work performed. Data for force account construction, however, are not included in the Census figures but are, to a large extent accounted for by the figures reported by the private organizations. Another important consideration pointed out by the Bureau is the elapse of a period of time between the award of a contract for construction and the performance of any sizeable proportion of the actual construction work.

The report includes information on employes and proprietors, payrolls, operating expenses and profit or loss, new construction and repairs, and private and public construction, for all kinds of contractors, including heating, piping and plumbing contractors. Summaries are presented by states and by geographic divisions by kinds of business.

[*"Census of Business, 1935—Construction Industry, Vol. I, Number of Establishments, Work Performed, Personnel, Payroll, and Cost of Materials." Prepared by George J. Lawrence; published by the U. S. Department of Commerce. Standard size, offset-printed, 116 pages. Limited number of copies available on request.*]

Homes for Workers

The Housing Division of the Federal Emergency Administration of Public Works has published an 87-page bulletin entitled "Homes for Workers" presented in very modern format. The publication points out the need for housing, cost of housing developments, and the possibilities of having better housing for workers in this country. According to the publication: "Our experience since 1933 indicates the probability that the Government is in housing to stay. . . . In spite of the loud objections of those who exploit the poor, however, its duty is to act vigorously in the field where private business cannot give honest value." A bibliography is included.

[*"Homes for Workers," published by the Federal Emergency Administration of Public Works. Paper-bound; 5¾ x 9⅛ in.; 87 pages; illustrated. For sale by the Superintendent of Documents, Washington, D. C.; price, 15c.*]

BRIEF REVIEWS

HOUSING. A report prepared by The Merchants' Association of New York to aid in the development of a plan which will bring about the solution of the housing problem by private enterprise on an economic basis rather than by the wholesale entrance of national, state, and local governments into the housing field. The report outlines the policies which The Merchants' Association believes should be followed by the various legislative agencies. [*"A Business View of the Housing Problems," Report of the Special Committee on Housing of The Merchants' Association of New York, January, 1937. Paper cover, 6 x 9 in., 18 pages.*]

COAL DE-DUSTING. Discusses the treatment of coal and coke for dust prevention. Among the subjects covered are dustproofing agents, measurement of dustiness, general principles of dustproofing, and substances used in treating solid fuels to decrease dustiness. [*"Dust-Prevention Treatment of Solid Fuels," by L. D. Schmidt. Information Circular I.C. 6932, published by the United States Bureau of Mines, Department of the Interior. Mimeographed, 8½ x 11 in., 10 pages.*]

AIR CONDITIONING. Explains non-technically the four principal functions of air conditioning, utilizing a series of cartoons. [*"How's the Weather?", published by the Air Conditioning Bureau of Omaha, Nebraska. Heavy paper cover, 6 x 9 in., 12 pages.*]

STEEL HEATING BOILERS. Simplified practice recommendation for steel horizontal firebox heating boilers which became effective January 1, 1937. Recommendation lists 19 sizes of boilers ranging from 1800 to 35,000 sq. ft. of steam radiator surface and from 2880 to 56,000 sq. ft. of water radiator surface for hand firing. Nineteen ratings are given for these boilers mechanically fired. Recommendation also includes B.t.u. per hour, heating surface, grate area, furnace volume, size of outlets, and number and size of safety valves for each size of boiler. [*"Simplified Practice Recommendation R157-37, for Steel Horizontal Firebox Heating Boilers." Published by the Division of Simplified Practice, National Bureau of Standards, Washington, D. C. Mimeographed, 14 pages including two charts.*]

FLUID-FLOW DESIGN. A discussion of the fundamental principles involved in fluid transportation. Presents information and charts on the calculation of flow in pipes and on economic pipe diameters. [*"Fluid-Flow Design Methods," by R. P. Genereaux. Published in Industrial and Engineering Chemistry; Vol. 29, No. 4; pages 385 to 388.*]

ELECTRIC WIRING HANDBOOK. This handbook surveys the field of wiring adequacy for building. It treats of electrical needs of the residence, factory, office, and store—interprets practice in installing wiring—and conforms with the requirements of the American Standard Codes set up for fire prevention and personal safety. It is a booklet on why adequate wiring is needed, what must be installed to supply those needs, and where it should be placed. Every attempt has been made to include all the factors for wiring small jobs. For large jobs only an outline of the procedure is indicated. [*"Handbook of Interior Wiring Design," Second edition. Prepared by Industry Committee on Interior Wiring Design, Room 2650, 420 Lexington Ave., New York. Paper cover; 8½ x 11 in.; 80 pages; single copies, $1.*]

NOMOGRAPHIC CHARTS. Purpose of the book is to teach the reader to construct a simple type of alignment chart for any type of equation no matter how involved and to do this without the necessity of a theoretical background other than algebra. [*"Alignment Charts, Their Construction and Use," by Paul N. Lehoczky. Circular No. 34, Engineering Experiment Station, The Ohio State University, Columbus, Ohio. Paper cover; 6 x 9 in.; 62 pages; price, 40c.*]

HEAT TRANSFER. A reprint of a series of lectures delivered by the author at a number of universities on the subject of heat transfer in evaporation and condensation. First lecture deals with experiments on latent heat of high-pressure steam, the second with simpler and more qualitative features of evaporation, the third on the less simple quantitative results, the fourth with the theory of a film condensation, the fifth with experimental proof of the theory, and the sixth with deviations from the theory and some recent ideas about dropwise condensation. [*"Heat Transfer in Evaporation and Condensation," by Max Jakob. Published by the Engineering Experiment Station, University of Illinois, Urbana, Ill. Reprint No. 10. Paper cover; 6 x 9 in.; 75 pages; price, 35c.*]

HEAT TRANSFER. Gives data on and describes tests to determine the heating and the pressure drop of a fluid between two parallel flat plates such as are used in certain commercial heat exchangers. Plates having spaces of ⅛, ¼, 9/16 in. were tested. [*"Heat Transfer and Pressure Drop in Rectangular Air Passages," by Lawrence Washington and William M. Marks. Published in Industrial and Engineering Chemistry, March, 1937; Vol. 29, No. 3; pages 337 to 345.*]

NEWS OF THE MONTH

Building Code Prepared for All New England

BOSTON — A new uniform building code which has been in the process of preparation for the past ten years was finished at the recent New England Building Officials' Conference and adopted with some minor changes in phraseology. The conference recommended that it be used as a uniform building code for all the cities and towns of New England. For the city of Boston, however, a special act by the legislature will be necessary for its adoption.

The code will be printed shortly and copies made available for all New England communities. It has approximately 400 sections and is believed to be the most workable code and most complete of any ever drawn up. It has the endorsement of builders, architects, and engineers, many of whom helped in drawing up various sections and served on th committees, and it represents the contribution of the smallest town as well as the largest city.

Uniformity is provided in all provisions that are possible of such treatment. For instance, structural work must be as strong for a building in Cambridge as for the same kind of a building in Boston or Portland, Me. Adoption of that principle is intended to overcome the present tendency of industries to locate and develop in a community because the building laws permit cheaper construction than those of another community.

Occupancy of the building is given an important place, with ten chapters devoted to it. The principle has been followed that a structure designed for an audience of 500 people must be as safely constructed in a small town as in a large city, use of the building being the governing factor rather than the local population. And whenever changes in occupancy are contemplated, the code will still follow the use of the building.

One of the newest features is the board of technical standards. For the city of Boston the composition of that board is definitely prescribed, because Boston has to take its building code from the legislature; but other cities and towns will find provisions for the creation of corresponding authority in the testing of building materials. New building material is constantly reaching the market, unknown to and untried by builders and architects. Use of such untried material will not be permitted under this code, before it has been certified by the testing authority.

One entire chapter is given over to chimneys and heating apparatus, another to gas fitting, gas service, fixtures and appliances, and considerable attention is paid in various chapters to vertical openings, light and ventilation.

6 New A.C. Radio Studios

NEW YORK—An extensive building program involving expansion and improvement of six National Broadcasting Company plants in key cities of the red and blue networks, was announced today by Lenox R. Lohr, president of NBC.

The project includes immediate construction of new studios at Philadelphia and Schenectady, the completion of a building already under way in Washington, and the subsequent provision of new facilities at Hollywood, San Francisco, and Cleveland.

Changes and new developments in the six cities will be made with a view to placing the broadcasting plants on the same technical basis as the Radio City and Chicago studios. Plans include complete air conditioning, soundproofing and acoustical treatment, and lighting devices designed to reduce heat radiation to a minimum. They also provide space for future development of television activities.

Boiler Inspectors to Meet

NEW YORK—The 11th general meeting of the National Board of Boiler and Pressure Vessel Inspectors will be held at the Hotel McAlpin here May 24-26. This Board was organized in 1919 for the purpose of securing uniform approval of specific designs of boilers and pressure vessels through the adoption by various states and cities of one code of rules and of one standard stamp to be placed on boilers and pressure vessels constructed in accordance with such rules.

There will be morning and afternoon sessions on each of the three days. All of the sessions will be open to those interested; registration will be required but there will be no charge.

Major changes in the construction and design of boilers and pressure vessels are being made, together with the development of new materials contemplated in their construction and these changes and new materials are the basis on which the program for this meeting has been developed. The subjects to be discussed are of importance and interest to engineers, manufacturers and operators of these vessels and the papers will be presented by foremost authorities on the various subjects. Among these subjects are: Use of Non-Ferrous Alloys in the Construction of Pressure Vessels; Use of Ferrous Alloys in the Construction of Pressure Vessels; Latest Developments of Steam Generating Plants; Design and Testing of Safety Valves; Welding of Power Plant Piping; The Non-Destructive Inspection of Welded Pressure Vessels; Developments of Forced Circulation Boilers; General Problems in the Repair by Welding of Boilers, Pressure Vessels and Pipe Lines; General Problems of Welding in Light of Today's Experience; Safe Operation of Low Pressure Steam Boilers and Hot Water Vessels.

Fire Regulations Explained to Boston A. C. Bureau

BOSTON—Owing to the New England Building Officials' Conference at the Hotel Statler April 12-14, the regular April meeting of the local Air Conditioning Bureau was omitted. Instead the Bureau had an exhibit at the conference and members attended the sessions of the building conference.

April 13 was devoted to round table discussions of sections of the building code, followed by a discussion of proposed regulations for the installation of air conditioning and discussion of the problems confronting building inspectors. The third day was devoted to reading of various papers, and an address by Robert S. Moulton, technical secretary of the National Fire Protection Association, on the regulations for the installation of power-operated air conditioning, dust, stock and vapor removal systems as recommended by the NFPA.

Ventilation of kitchens was discussed by Arthur N. Rutherford, chief inspector of buildings, New Britain, Conn.

1935 Sales of Heating Equipment

WASHINGTON—Sales of heating equipment for central building heating during 1935 totaled over $146 million, according to figures from the Census of Manufactures recently released. This compares with a total of slightly over $140 million in 1931. Comparable figures for 1933 are not available. Detailed figures are shown in the accompanying table.

CENSUS OF MANUFACTURES, 1935 AND 1931, COVERING VARIOUS HEATING EQUIPMENTS
(Comparable data for 1933 not available)

EQUIPMENT	1935		1931	
	NUMBER	VALUE	NUMBER	VALUE
Cast iron boilers	64,011	$6,257,995	99,424	$9,358,999
Cast boilers, number not reported	—	7,368,787	—	5,057,282
Steel heating boilers	—	—	—	—
Steel boilers, number not reported	7,770	2,496,009	16,864	3,401,081
Parts for heating boilers	—	2,059,148	—	1,240,065
Cast iron radiators	—	12,035,645	—	15,326,304
Copper radiators	—	993,921	—	1,339,379
Gas- and oil-fired radiators	—	232,431	—	307,375
Warm air furnaces	210,758	14,339,284	207,375	18,274,414
Furnaces, number not reported	—	1,808,672	—	—
Furnace parts and registers	—	6,330,969	—	6,367,173
Unit heaters	15,996	2,077,888	20,255	3,531,339
Unit heaters, number not reported	—	1,377,477	—	1,635,531
Oil burners, domestic, mechanical drive	112,870	12,451,079	86,011	14,945,314
Domestic burners, mech., no. not rep.	—	1,577,571	—	—
Oil burners, natural draft	2,627	103,888	2,747	225,514
Burners, draft not specified	—	1,753,262	—	—
Commercial oil burners	2,050	401,257	—	—
Boiler burner units (oil)	9,835	2,447,968	—	—
Boiler-burners, number not reported	—	325,509	—	—
Furnace-burner units (oil)	3,710	1,003,959	—	—
Gas heating boilers	23,316	725,197	—	—
Gas boilers, number not reported	—	319,586	—	—
Parts for oil and gas burners	—	1,117,411	—	977,990
Fittings	—	18,500,876	—	13,902,836
Valves	—	22,499,275	—	20,775,845
Thermostats	7,927,236	12,297,011	1,169,800	7,913,344
Thermostats, number not reported	—	2,549,850	—	3,532,547
Reducing valves	—	2,471,685	—	1,261,029
Regulators	—	2,372,694	—	2,574,227
Traps	—	2,137,560	—	2,799,288
Other specialties	—	3,579,094	—	5,623,750
TOTAL	—	$146,012,958	—	$140,370,626

Furnace Men Schedule Meeting

CLEVELAND — The mid-year convention of the National Warm Air Heating and Air Conditioning Association which is to be held in the Hotel Cleveland here, June 9-10, promises to be another great occasion for the furnace industry, and as usual will attract a large attendance.

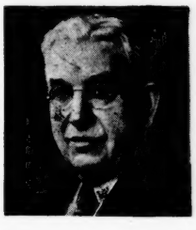
A preview of the program indicates the topics for presentation are being carefully selected for their practical value to all identified with the furnace system for heating and for furnishing other phases of air conditioning in the home and smaller buildings. The session hours will be arranged to afford ample time for personal contacts, committee meetings and business conferences. Meetings of the board of directors and the Association's standing committees will occupy Tuesday, June 8.

Entertainment features will include a luncheon, dinner party, and an afternoon golf tournament.

The Association extends a cordial invitation to all interested to attend.

Reeder Sets Record

KNOXVILLE, TENN.—With all the talk of retirement at 70 now current it is refreshing to note the case of Frank C. Reeder, who recently passed the 70th milestone. Mr. Reeder is service and field engineer for the Fulton Sylphon Co., and is affectionately known as "Uncle" to nearly everyone in the heating industry. He has traveled more than a million miles over the North American continent from British Columbia to Florida, and from Nova Scotia to California. Corporation president or steamfitter's helper—he calls them all by their first name. Hale and hearty last year Uncle traveled over 10,000 miles, was responsible for $100,000 volume of business, trained six new salesmen, spent 36 hr. on one job without sleep, and he found time in-between to design and patent two new temperature regulating devices, for which there is already a wide sale. How many youngsters can beat that record?



Locomotives Supply Heating Service

BIRMINGHAM, ALA.—A new use for railroad locomotives was found during the Ohio River flood, according to W. I. Lightfoot, general passenger agent of the Louisville & Nashville Railroad in Birmingham. Louisville was several feet under water for several days, and that meant all heating plants located in basements were out of commission.

As soon as the waters receded sufficiently for the Union Passenger Station and office buildings to be used, the temperature in them was too low to permit work. L. & N. Engineers got busy, ran two large locomotives to the vicinity of the station and the buildings occupied by L. & N. officials, connected one of them with a fan that blew steam into the passenger station, and through connections with pipes pumped the steam into radiators throughout the office buildings, offices on the 11th floor, Mr. Lightfoot said, being as comfortable as when the regular heating system was in operation.

Toronto Chapter Hears Talks on Glass

TORONTO—"The Use of Fiber Glass and Air Filters" and "Glass Blocks in Construction" were the subjects of talks by Messrs. Meyers and Lockart at the April meeting of the Ontario Chapter, ASHVE, held at the Royal York Hotel, April 2. One hundred and sixty-five members and guests attended.

Officers Address ASHVE Chapters

NEW YORK—D. S. Boyden, 1937 president of the ASHVE, began the president's annual tour of the Society chapters April 9 when he addressed the Washington, D. C., chapter. Mr. Boyden's subject, which he spoke on before various chapters, was "Economic Uses of Purchased Steam." His talk was presented before all the chapters Mr. Boyden visited with the exception of the Oklahoma City group. His itinerary follows: St. Louis, April 12; Kansas City, April 13; Oklahoma City, April 14; Dallas (Texas Chapter), April 15; Los Angeles (South California Chapter), April 20; Seattle (Pacific Northwest Chapter), April 30; Winnipeg, May 5; Minneapolis, May 8; Chicago (Illinois Chapter), May 9; Milwaukee (Wisconsin Chapter), May 11.

E. Holt Gurney, first vice-president of the Society, also attended the Washington meeting and made a short talk. Mr. Gurney covered a number of the chapters that Mr. Boyden missed in his trip. Mr. Gurney's subject is "An Engineer Goes Sight-seeing" in which he describes the five-month 'round-the-world trip from which he recently returned and during which he visited England, Africa, and the far east. Mr. Gurney spoke in Pittsburgh on April 19; Cincinnati, April 20; Cleveland, April 21, and Detroit, April 22.

A.C. for Southern Hotel

JACKSONVILLE, FLA.—An air conditioning system which allows each guest to regulate the air conditions in his room, will be installed in the Hotel George Washington here. The system will cool 280 guest rooms, meeting rooms, lobbies, dining rooms, and recreation centers.

Cost of the system will be about $100,000. The amount of air handled will be 7000 lb. per min. More than 30 tons of galvanized sheet steel will be needed for ductwork.

48 A. C. Jobs Added

CHICAGO—Forty-eight air conditioning installations totaling 1687 ¼ tons were made in this city during March according to the Commonwealth Edison Co. The connected horsepower of these jobs totaled 2160 ¼. The installations were broken down in numbers as follows: doctors offices, 2; funeral parlors, 3; industrial buildings, 4; general offices, 7; restaurants, 9; stores, 14; theaters, 6; residences, 1, and miscellaneous, 2.

300 Tons of A.C. for Dutch Ship

NEW YORK—The new transatlantic liner, *Nieuw Amsterdam*, Holland's "ship of peace," will carry the largest air conditioning system afloat when she is launched April 10 on the River Maas in the Netherlands. The 300-ton cooling system was designed especially for the 33,000-ton liner by Carrier Corp., Newark, N. J., which installed the air conditioning systems on the *Queen Mary* and *Normandie*. The *Nieuw Amsterdam* system is 75 tons larger than that of the *Queen Mary* and 114 tons larger than the *Normandie* equipment.

This system, capable of producing daily cooled air equal to that given off by 300 tons of melted ice, will condition the liner's three dining rooms, modern theater, and beauty and barber shops.

Largest ship ever built in the Netherlands, the *Nieuw Amsterdam* has been termed a ship of peace as she has been built without any provision for the addition of future armaments. She will enter the transatlantic service in the spring of 1938 as flagship of the Holland-America Line, running between Rotterdam and New York.

Frank H. Adams Honored

TOLEDO — The associates of Frank H. Adams, vice-president and general manager of the Surface Combustion Corp., Toledo, Ohio, honored him with a dinner at the Toledo Club on March 29, celebrating his 25th anniversary with the Henry L. Doherty organization. Mr. Adams joined the Doherty company shortly after his graduation in 1908 from the University of Missouri and until 1916 was engaged in handling its engineering work in Colorado and Louisiana. In 1916 he was called to the New York office of the company and in 1923 was made vice-president and treasurer of the Combustion Utilities Division. In the early part of 1926, he was made vice-president and general manager of Surface Combustion Corp. and moved to Toledo.

Winnipeg District Heating

WINNIPEG—The annual report for 1936 of the City of Winnipeg Hydro Electric System shows a net profit of $8513 for the steam heating branch of that utility. The total revenue from steam sales in 1936 was $389,036 as compared with $365,933 in 1935. The only extensions made to the steam heating utility were for new services, the net increase amounting to slightly over $3000.

Gilbert & Barker Manufacturing Company held its annual air conditioning and oil burning dealers' meeting April 7-9 at Springfield, Mass. Photograph shows banquet on the evening of April 9.

Osteopaths Urge A.C. Inspection

NEW YORK—At the 17th annual convention of the Eastern Osteopathic Association held here April 3-4, attended by over 800 physicians, the following resolution was adopted:

Whereas, proper air conditioning is a definite public health measure,

Whereas, oxygen is vital to health and the continued recirculation of air without the addition of a fresh supply of oxygen is harmful,

Whereas, proper humidity and temperature control creates comfort,

Whereas, the improper forced circulation of conditioned air is a threat to health by creating ill-directed drafts,

Therefore Be It Resolved, that we urge public health officials to redouble their efforts in inspecting all places where air conditioning is in use, especially theaters, concert halls, and vehicles of transportation, to the end that this potentially valuable development may fully serve mankind.

Burner Makers Meet

NEW YORK—A group of oil burner manufacturers held a two-day meeting, April 20-21, at the Hotel Statler in Buffalo to discuss informally practices and objectives affecting the entire industry. The keynote of the meeting was the need for the industry to arrive at tangible, constructive solutions to existing problems as they affect manufacturers, dealers, and the public.

During the sessions a number of specific subjects were thoroughly discussed including the advancement of cooperative regional efforts, the Lamneck bill which has been proposed in Washington to make possible industry codes under supervision of the Federal Trade Commission, competitive trade practices and terms as well as the need for a sound trade and public relations program which, it was suggested, be linked with the OBI seal.

Home Show for N. Y.

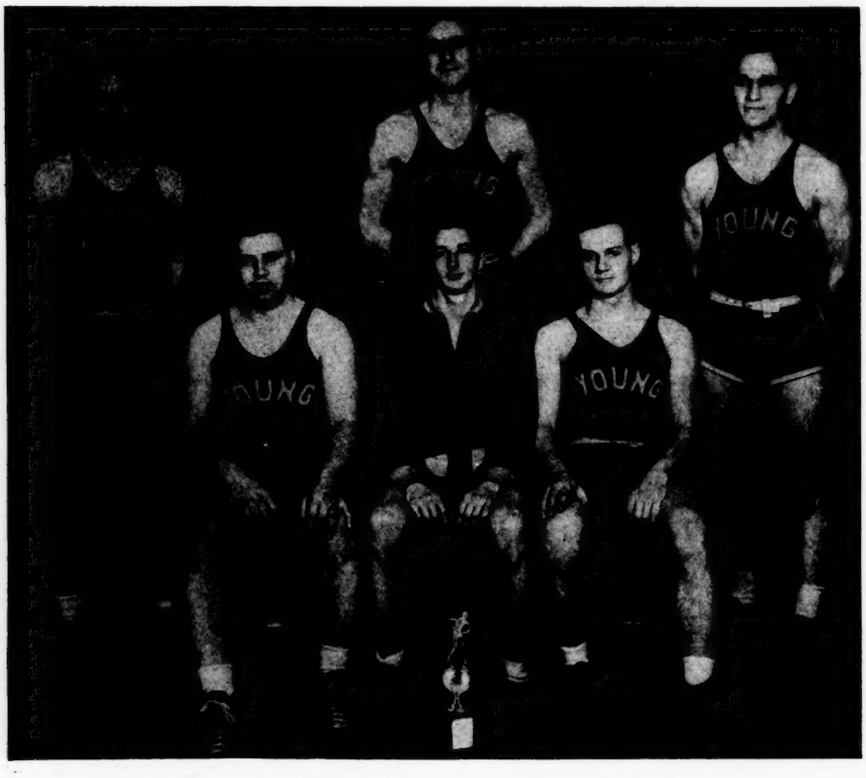
NEW YORK—Approximately $1 million will be spent on the North American Homes Exposition at Madison Square Garden here May 12-23. One exhibit alone—the House of Tomorrow—will cost $100,000 to build and furnish. Three model houses and three apartments, full scale on the two-acre (92,000 sq. ft.) floor of the exhibition hall, will serve to display building materials, furnishings, and home appliances, including heating and air conditioning plants.

Booth space was 70% sold more than a month before the opening date, L. Porter Moore and R. L. Purdon, co-directors, announced. The immediate response of all manufacturers and dealers allied with the home building industry indicates a healthy revival in housing construction this year, they said.

The show has the endorsement of the Federal Housing Administration, which will exhibit one of its low price small houses, and the Manufacturers Housing Promotion Council, many of whose members are taking active part. The New York City Housing Authority will exhibit a reproduction of an old-law tenement contrasted with a modern PWA housing project, such as are now under construction in the Harlem and Williamsburg sections of New York.

A.C. in Boston for First Quarter

BOSTON—A total of 113½ hp. has been added to the connected load of the Boston Edison Company through air conditioning installations from January 1 to March 1 of this year. These include a 55-hp. installation for the Noyes-Buick Company's building, one of 12 hp. for the Paddock restaurant, and another of 10 hp. for the famous Thompson's Spa on Washington Street. Two Thom McAn chain shoe stores have also been air conditioned, one with 3½-hp. and the other with 5½-hp. equipment. All the installations are for year-round conditioning.



Young Radiator Company's 1936-37 basket ball team, winner of the Racine (Wis.) Major League championship.

OBI Sponsors Boston Meeting

BOSTON—The first Oil Burner Institute Boston regional meeting was held April 7 at a luncheon at the Copley Plaza. Regional director F. H. Van Blarcom, Lynn Products Co., organized the meeting with the cooperation of J. E. Gould, president of The Boston Oil Burner Associates.

The purpose of the meeting was to bring together representatives of the burner, oil and service industries to discuss local problems and to stimulate group action in cataloging and acting upon conditions affecting both the trade and the public. Charles N. Lockwood, president, and G. Harvey Porter, managing director of OBI presented the aims of the Institute in fostering better conditions and practices within key markets.

During the general discussion which followed a number of important points were introduced most of which, it was decided, would be made the subject of another meeting of the local group. Those present requested Mr. Gould to issue a call for such a meeting at which time practices will be cataloged and specific assignments will be made in an effort to arrive at constructive solutions.

Mr. Porter told the meeting that the most effective work can be done by the efforts of the local group but that OBI will lend its support to constructive objectives, and will assume the responsibility of bringing matters with which they should be concerned to the attention of burner manufacturers and members of the petroleum industry.

ASHVE Summer Program

NEW YORK—Papers on ventilation and summer air conditioning will predominate at the summer meeting of the American Society of Heating & Ventilating Engineers to be held at Swampscott, Mass., June 23-26.

On the evening of the first day the president's reception will be held with music and dancing. Technical sessions will be held at 9:30 in the morning from the 24th to 26th, inclusive.

On the afternoon of June 24 those attending will have an option of playing golf or going on a boat trip, while on the evening of that day there will be an informal party. The golf tournament will be held the afternoon of the 25th and on the evening of that day the banquet will be held at 7:30.

The technical program follows:

JUNE 24

The Adaptability of Pre-Cooling Coils to Air Washer Systems, John Everetts, Jr.; Degree-Days for Summer Air Conditioning, A. D. Marstons.

Study of Summer Cooling in the Research Residence Using Water at Temperatures of 52 and 46 F, A. P. Kratz, S. Konzo and E. L. Broderick.

Cooling Load Analysis of a Bank Building, John James.

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Ventilation Requirements, Part 2, C. P., Yaglou and W. N. Witheridge.

Performance of Fin Tube Units for Air Cooling and Dehumidifying, G. L. Tuve and C. A. McKeeman.

The Cooling and Heating Rates of a Room With Different Types of Steam Radiators and Convectors, A. P. Kratz, M. K. Fahnestock and E. L. Broderick.

Report of A.S.H.V.E.-A.S.R.E. Committee on National Standards for Air Conditioning Applications, L. A. Harding, Chairman.

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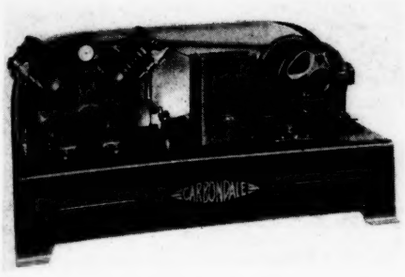
Simplified Method of Testing and Rating Air Cleaning Devices, Arthur Nutting.

Direct Reading Effective Temperature Indicator, J. R. Parsons.

Infiltration Effects on Heating Grant Building, F. C. Houghten.

NEW EQUIPMENT



Carbondale Refrigerating Units

NAME — Self-contained low-pressures refrigerating units.

PURPOSE — Refrigerating units designed to employ either freon or methyl chloride for either air conditioning or general refrigerating purposes.

FEATURES—The compressor unit is compact, is mounted on a sturdy welded steel base and requires small floor space as well as low head room. Both suction and discharge valves are of the light-weight type. The V-type compressors, from 4 to 8 cylinders, are made of special metal which is said to combine extra strength and great density. A self-adjusting motor bedplate is provided to maintain proper belt tension at all times. The 8-cylinder unit has adjusting screws for the motor baseplate. Receiver is integral with a shell-type condenser which is fitted with copper-finned condenser tubing of welded construction throughout.

LITERATURE AVAILABLE—Bulletin No. 1121.

MADE BY—*Carbondale Div., Worthington Pump and Machinery Corp., Harrison, N. J.*

Viking Circoolator

NAME—Circoolator ventilating fan.

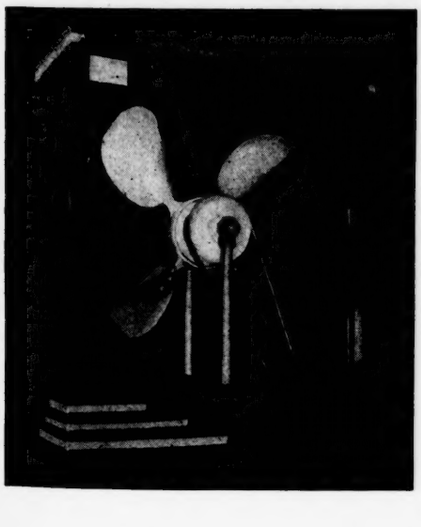
PURPOSE—For residential cooling by replacing warm summer air with cool outside air.

FEATURES—Unit consists of a fan and motor mounted in a cabinet finished in blue morocco enamel with silver stripes. The Helixoid fan which is used is said to be very silent. Fan is connected to the electric motor by a V-belt drive which is automatically kept tight by a self-adjusting base. The entire fan assembly is mounted on rubber cushions so as to isolate the vibration. The Circoolator can be installed by placing it next to a window or other opening. An attractive grille is furnished to prevent injury from the moving fan blades. For homes having unfinished attics with no openings to the downstairs there is available a Circoolator attic unit which consists of a wooden grille for the ceiling and an air-tight vent box with all necessary fittings for the attic. The vent box is a sound absorbing connection between the ceiling grille and Circoolator. An automatic firedoor is also provided in this equipment.

SIZES AND CAPACITIES — Available in three sizes—30, 39, and 45 in. having capacities of 7000, 10,000, and 14,000 c.f.m., respectively.

LITERATURE AVAILABLE—Bulletins No. 44 and a selector sheet and price schedule 45-A.

MADE BY—*Viking Air Conditioning Corp., Main & Center Sts., NW., Cleveland, Ohio.*



American Radiator Expansion Tank

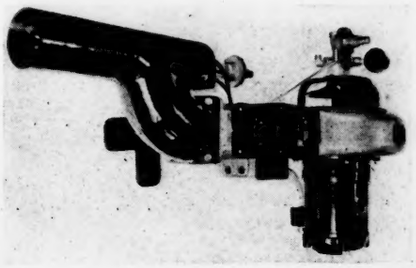
NAME—Self-filling Arcoloy expansion tank.

PURPOSE—Rust-resisting expansion tank for any type of hot water heating system.

FEATURES—A float valve, easily accessible through sliding cover in tank, offers provision for automatic supply of water at all times. The opening in the top of the tank also serves as a safety feature for either gravity or forced systems by preventing the development of pressure as the water is heated, and in addition permits a forced warm water system to operate as an open system. According to the manufacturer, Arcoloy has a higher resistance to ordinary corrosive agents than pure copper.

SIZES AVAILABLE—10, 20, and 30 gal.

MADE BY—*American Radiator Co., 40 W. 40th St., New York.*



Scott-Newcomb Oil Burner

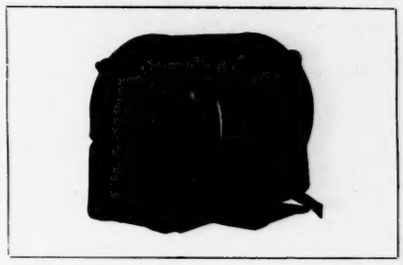
NAME—Conversion oil burner, model CJL.

PURPOSE—Designed to burn oil from 7 to 12 gal. per hr.

FEATURES—Pump has no gaskets and operates with a dual seal. Air adjustment is made so that an extremely fine adjustment can be had and an acoustical material is located in the air receiver to reduce combustion and spark noise. Four fuel screens are used, one large screen in the line, one at the entrance of the cut-off valve, and one just before each nozzle. A gyro dual air mixer is employed.

CAPACITIES—7 to 12 gal. of oil per hr.

MADE BY — *Scott-Newcomb, Inc., 1922 Pine St., St. Louis, Mo.*



Wagner Resilient-Mounted Motors

NAME—Wagner resilient mounting for motors.

PURPOSE—Annular resilient mountings for Wagner motors from ⅛ to 1 hp.

FEATURES—This type of mounting is said to have the advantage in that there is less vibration and less noise since the rubber mounting supports which absorb the vibrations are as close to the shaft center as possible. The large rings of rubber which support the motor are vulcanized to inner and outer steel rings. The motor base is made of rolled sheet steel and is shaped in the form of a cradle for supporting the motor. The motor can easily be removed from the base by loosening latch nuts and removing the latches.

AVAILABLE ON—Repulsion start induction, split-phase, capacitor and polyphase types of Wagner motors. Also available with belt-tightener bases.

MADE BY—*Wagner Electric Co., 6463 Plymouth Ave., St. Louis, Mo.*

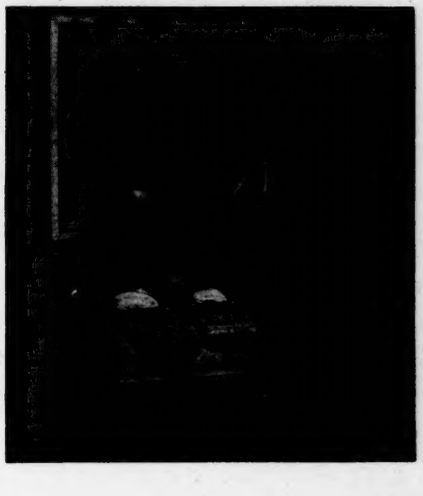
Hebler Fuel Ratiometer

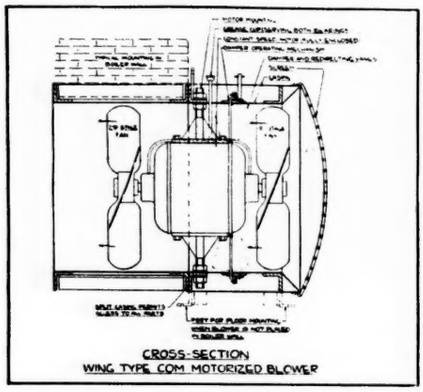
NAME—Hebler fuel ratiometer.

PURPOSE—For checking carbon dioxide percentage and stack temperature of coal-, gas-, and oil-fired boilers.

FEATURES—The fuel ratiometer is composed of an instrument which utilizes the thermal conductivity principle for measuring carbon dioxide combined with another instrument which uses the thermo electric principle for measuring stack temperature. These two instruments have been combined into a portable apparatus. A hand aspirator is provided with each instrument together with a combination thermocouple and gas sampling holder. The temperature indicating instrument is calibrated for a range of 100 to 1000F, and the gas gage from 0 to 20% carbon dioxide.

MADE BY—*Wm. O. Hebler Co., 830 Broad St., Newark, N. J.*




CROSS-SECTION
WING TYPE COM MOTORIZED BLOWER

Wing Blower

NAME AND MODEL NUMBER—Type COM blower.

PURPOSE—Blowers for supplying air at pressures of 6 or 7 in. of water for forced draft supply in hand-fired boilers, stoker-equipped boilers, oil- or gas-fired boilers or for secondary air supply of pulverized fuel burning boilers.

FEATURES—Units consist of a constant speed electric motor, an integral damper control, and two propeller type fans, one mounted on each end of the two extended shafts. An air redirecting mechanism is built in between the two propeller fan wheels. The entire assembly is placed within a simple cylindrical casing arranged for ready accessibility. Units are built for either horizontal or vertical mounting and can be installed directly in the brick setting or concrete foundation walls of the boiler.

MADE BY—*L. J. Wing Mfg. Co., 154 W. 14th St., New York.*

General Radio Noise Meter

NAME AND MODEL NUMBER—Sound level meter 759-A.

PURPOSE—For determining the intensity of sound in various locations and of various pieces of equipment.

FEATURES—Instrument has standardized readings which meet the tentative standards of the American Standards Association. Has a non-directional pick-up which does not have to be pointed at the noise source. Is self-contained and portable and weighs 23½ lb. Requires no battery adjustments and has three weighting networks to secure the correct frequency response for low, high and extremely high noise levels. It is said that anyone can operate this meter within a few seconds. It is only necessary to turn the instrument switch on, hold it near the source of noise, adjust a single knob until the meter stays on the scale and then add the reading of the meter and the setting of the attenuator for the correct answer in decibels.

MADE BY—*General Radio Co., Cambridge, Mass.*

Oakite Spray Water Sterilizer

NAME—Airefiner.

PURPOSE—To sterilize spray water and to prevent the growth of slime and algae deposits in air conditioning spray systems.

FEATURES—This material is said to be completely soluble, to transmit no odor to water or air and to provide a stable, colorless solution that is safe and non-toxic. It is non-corrosive to metal surfaces and helps prevent water scale formation. The manufacturer states that the use of this material will improve the efficiency of spray systems since it destroys the growth which tends to accumulate on surfaces directly in contact with recirculated water. It is also said that the material destroys the bacteria which accumulate in the recirculated spray water.

MADE BY—*Oakite Products, Inc., 22 Thames St., New York.*

Ideal Thermo-Grip Pliers

NAME—Ideal No. 10 electric pliers.

PURPOSE—Electrically heated pliers for sweating pipe fittings up to 4 in. in diameter.

FEATURES—The manufacturer states that these electric pliers are different from all other soldering tools in that they sweat joints without unsweating adjacent connections; that they hold the work firmly while soldering; they heat work evenly from both sides and eliminate open flame hazards. Pliers are said to be capable of soldering lugs up to 1050 amperes or sweating pipe fittings up to 2½ in. diameter under continuous operation. When used intermittently the pliers will handle pipe up to 4 in. in diameter.

MADE BY—*Ideal Commutator Dresser Co., 1536 Park Ave., Sycamore, Ill.*

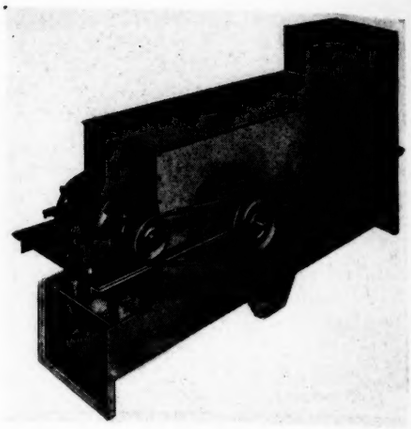
Maid-O'-Mist Boiler Protector

NAME AND MODEL NUMBER—Micro Water Boy boiler protector, No. 855.

PURPOSE—For preventing low water or excessive pressure in automatically-fired low pressure steam heating boilers.

FEATURES—This is a combination unit consisting of a Water Boy safety feeder, a Micro boiler protector and the necessary fittings for connection to the water glass. A Micro switch is used as a circuit breaker for both low water and excessive pressure and is rated for ½-hp. motors from 125 to 460 volts a.c. The switch is normally in an open position and is only closed when the float raises and snaps the switch by a compound leverage. A bronze diaphragm in the float chamber prevents water or steam leaking into the switch box. When this diaphragm is subjected to excessive steam pressure it moves upward, breaking the contact with the switch until the pressure recedes. The amount of steam pressure affecting the diaphragm is regulated by a set screw.

MADE BY—*Maid-O'-Mist, Inc., 180 N. Wacker Dr., Chicago.*



Peerless Water Savers

NAME—Peerless water savers.

PURPOSE—Evaporative condensers for cooling water used for condensing purposes in refrigerating systems.

FEATURES—In the base of the unit is a water reservoir in which the height of the water is controlled by a float valve. The motor is mounted on the outside of the casing and is connected to a Helicon fan and an atomizing disc. This disc rotates at a high speed and picks up water from the reservoir. The fine vapor from the disc is sprayed over the coils through which the refrigerant flows. The entire coil and fan assembly is accessible for inspection and cleaning by removing the housing. An eliminator assembly is provided to prevent the discharge of any solid water. Motor is of the standard, splash-proof, horizontal type. Coil is of continuous, tinned copper tubing and can be used with any refrigerant except ammonia.

SIZES AVAILABLE—Eight sizes ranging from 1 ½ to 25 tons. Larger sizes made to order.

MADE BY—*Peerless of America, Inc., 515 W. 35th St., Chicago.*

Francke Flexible Coupling

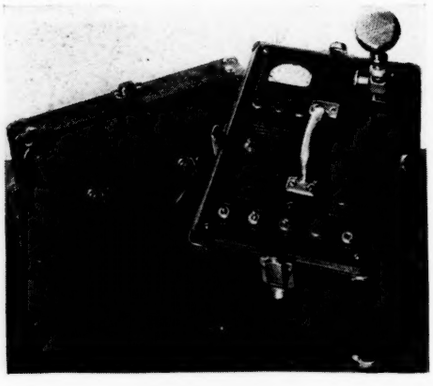
NAME—Francke fractional horsepower flexible coupling.

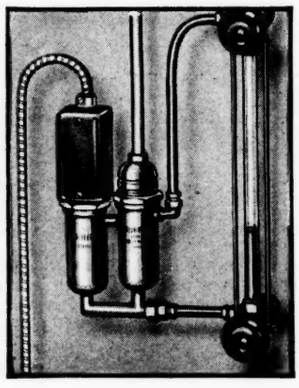
PURPOSE—All steel flexible coupling for fans, fuel pumps, generators, and similar equipment up to ¾ hp.

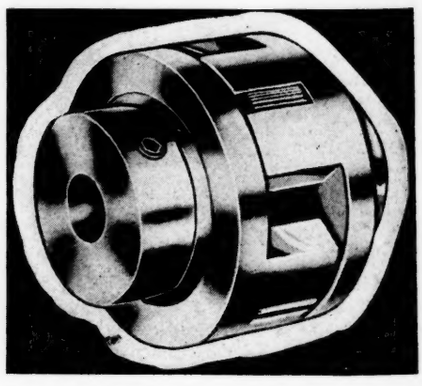
FEATURES—Coupling is said to provide free and independent lateral floating of the connected shafts and is silent at any speed. It has an assembled one-piece all-steel center member, large load carrying surfaces and accurate alignment surfaces. It is torsionally resilient and mechanically flexible.

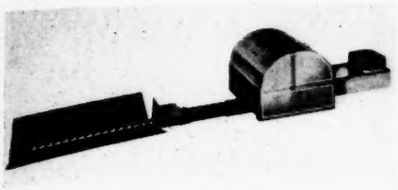
SIZES—For shafts up to ¾ in. in diameter and motors up to ¾ hp. at 1800 r.p.m.

MADE BY—*John Waldron Corp., New Brunswick, N. J.*









Free-Man Coal Burner

NAME—Free-Man relay bin feed automatic coal burner.

PURPOSE—For automatic firing taking the coal directly from the bin.

FEATURES—Conveyor screws made of high carbon chrome steel. They have a large diameter and are said to handle small sizes of coal without crushing. Transmission is of the continuous feed type with all gears running in oil. In this stoker the coal is relayed from one feed screw to another instead of using one long feed screw. Relay mechanism has a streamline housing which is easily removed to expose the working parts. Draft fan has controllable pitch blades and an air damper control.

MADE BY—*Free-Man Stoker Div., Illinois Iron & Bolt Co., 918 S. Michigan Ave., Chicago.*

Hexcel Portable Room Cooler

NAME—Hexcel portable room cooler.

PURPOSE—For room cooling utilizing chilled water.

FEATURES—Cooler has a four-blade fan which is capable of delivering 275 cu. ft. per min. at high speed. The water flow through the unit can be regulated from zero to 140 gal. per hr. Fan is driven by a two-speed motor using 47 watts. Unit is furnished in a brown crackle lacquer with brilliant chromium trim. Cooler is 54½ in. high, stands on a 17¾ in. base and weighs 80 lb.

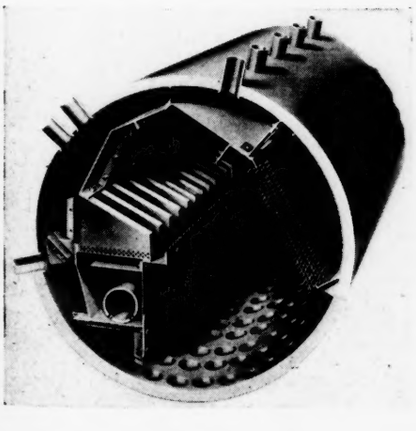
MADE BY—*Hexcel Radiator Co., Racine, Wis.*

Combustion Engineering Steam Washer

NAME—Bubble-type steam washer.

PURPOSE—For removing entrained solids from steam by forcing it to bubble through clean feedwater.

METHOD OF OPERATION—The feedwater enters the trough at the lower left through the longitudinal perforated pipe and spills over the notched weir. Mounted over the trough are a series of compartments, or hoods, open at the bottom and left and having perforations near the bottom of the side walls. These hoods are joined together by plates at the left and over them is bolted a continuous plate which extends to the top of the drum. Thus the steam entering the drum through the tubes at the left is compelled to pass into the hoods and out through the apertures, and bubbles through the feedwater, in which operation the entrained solids are removed. The actual washing of the steam is obtained not alone by bubbling through the water but also by the violent mixing of steam and water between the elements as created by the velocity of steam through the perforations. The construction is such as to prevent comingling of the feedwater with the water in the drum. The screen at the right is for the removal of moisture that may be carried along with the steam.



FEATURES—The washer is so located as to leave space for access for cleaning without removing it from the drum.

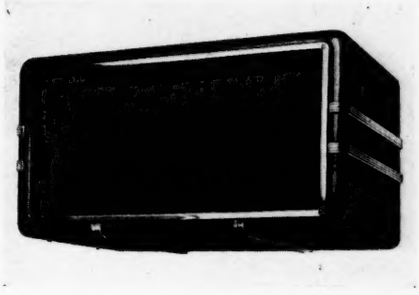
MADE BY—*Combustion Engineering Co., Inc., 200 Madison Ave., New York.*

General Refrigeration Pump Coolers

NAME AND MODEL NUMBER—Unit coolers Models F116, M116, W116, F216, M216, and W216.

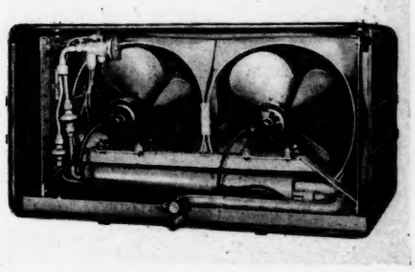
PURPOSE—For comfort cooling utilizing circulating cold water or direct expansion of Freon or methyl chloride.

FEATURES—Suspended type of propeller fan unit for cooling and dehumidification of air.



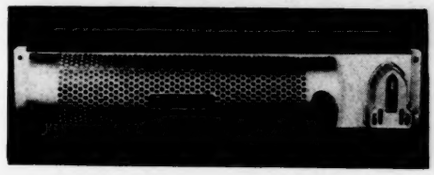
Front, Model 216

Unit has a metal casing finished in walnut brown with stainless steel trim and has a Uni-Flo grille furnished as standard equipment. Cooling coils are constructed of copper tubes with metallically bonded copper fins. F and M models are arranged for direct expansion of Freon and methyl chloride, respectively, while W models are for cold water. A heat interchanger is provided on the F and M models to increase the refrigerating capacity of the unit by sub-cooling the liquid and also to reduce suction line sweating by superheating the suction vapor. Thermostatic expansion valves and liquid strainer are provided on the F and M units. Fan motors have 6-ft. rubber sheathed conductor cord terminating in a two-prong attachment plug for electrical connection. The 116 models have a single motor and fan and deliver 600 c.f.m. while the 216 models have two fans delivering 1200 c.f.m.



Rear, Model 216

MADE BY—*General Refrigeration Sales Co., Beloit, Wis.*



Rockwood Electric Space Heater

NAME—Rockwood electric space heater.

PURPOSE—An automatic space heater for small installations, such as watchmen's gate houses, display windows equipped with water sprinkler systems, electric pump houses, and in isolated pipe enclosures.

FEATURES—The heater consists of a heating element, control thermostat, thermometer, pilot light and 3 in. outlet box mounted on a rigid pressed metal frame. The heating element is protected by a perforated pressed metal guard. It is said that installation can be made quickly and economically since only four screws are required to fasten it to a wall. The thermostat can be adjusted to operate between any selected temperature range from between 35 to 60F. A red bull's eye glows to indicate when the heater is operating.

SIZES AND CAPACITIES—Standard model is rated at 500 watts 110 volts a.c. or d.c. Special models to operate on 220 or 440 volts a.c. or d.c.

MADE BY—*Rockwood Sprinkler Co., 38 Harlow St., Worcester, Mass.*

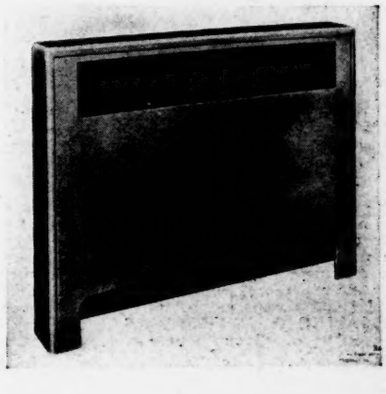
American Radiator Convector Enclosures

NAME—American Radiator convector enclosures.

PURPOSE—Enclosures for convector type radiator.

FEATURES—Enclosures are made with horizontal discharge grilles which are integral with the front panel of the enclosure. Enclosures are available for all sizes of both Arco convectors and New Murray radiators. The inlet arch is the same as the company's present free standing enclosures and the discharge grille can be either 3¾ in. or 4¾ in. high with the horizontal bars spaced on ½ in. centers. The removable front panel of the enclosure is made with a lock strip channel that provides additional stiffness and holds the plate in place the entire length of the enclosure. Optional features include pull chain dampers, top outlet grilles, custom-built units in other than standard length and height, and panel molding to permit a series of enclosures to be installed together.

MADE BY—*American Radiator Co., 40 W. 40th St., New York.*



Degree-Day Figures for March, 1937

HEATING & VENTILATING continues its ninth year of publishing degree-day data for various large cities.

	Albany, N. Y.	Atlanta, Ga.	Baltimore, Md.	Birmingham, Ala.	Boston, Mass.	Buffalo, N. Y.	Burlington, Vt.
Degree-days for March, 1937	1043	449	718	406	954	1151	1276
Degree-days, Sept. 1, 1936 to Mar. 31, '37	4477	2507	3738	2215	4860	5595	6513
Degree-days, Sept. 1, 1935 to Mar. 31, '36	5766	3046	4280	2743	5320	6143	6928
Degree-days, Sept. 1, to Mar. 31, Normal	5847	2759	4162	2339	5230	5799	6690

	Cheyenne, Wyo.	Chicago, Ill.	Cincinnati, Ohio	Cleveland, Ohio	Columbus, Ohio	Denver, Colo.	Des Moines, Iowa
Degree-days for March, 1937	1068	997	828	1034	884	859	959
Degree-days, Sept. 1, 1936 to Mar. 31, '37	6573	5465	4458	4986	4671	5393	6121
Degree-days, Sept. 1, 1935 to Mar. 31, '36	6429	6097	5036	5602	5336	5125	6699
Degree-days, Sept. 1, to Mar. 31, Normal	6173	5491	4344	5390	4816	5072	5825

	Detroit, Mich.	Dodge City, Kan.	Duluth, Minn.	El Paso, Tex.	Erie, Pa.	Evansville, Ind.	Fort Wayne, Ind.
Degree-days for March, 1937	1061	771	1322	378	1075	693	993
Degree-days, Sept. 1, 1936 to Mar. 31, '37	5618	3750	8470	2667	5166	4026	5397
Degree-days, Sept. 1, 1935 to Mar. 31, '36	6169	4861	8978	2247	5787	4514	6065
Degree-days, Sept. 1, to Mar. 31, Normal	5695	4646	7948	2383	5400	3988	5330

	Grand Rapids, Mich.	Harrisburg, Pa.	Hartford, Conn.	Indianapolis, Ind.	Kansas City, Mo.	La Crosse, Wis.	Lincoln, Neb.
Degree-days for March, 1937	1046	894	980	871	782	1097	878
Degree-days, Sept. 1, 1936 to Mar. 31, '37	5694	4608	4965	4857	4846	6974	5818
Degree-days, Sept. 1, 1935 to Mar. 31, '36	6193	5054	5284	5499	5235	7384	6272
Degree-days, Sept. 1, to Mar. 31, Normal	5827	4880	5303	4855	4966	6611	5547

	Little Rock, Ark.	Los Angeles, Calif.	Louisville, Ky.	Madison, Wis.	Memphis, Tenn.	Milwaukee, Wis.	Minneapolis, Minn.
Degree-days for March, 1937	502	216	725	1123	532	1050	1180
Degree-days, Sept. 1, 1936 to Mar. 31, '37	3013	1282	4052	6671	3028	5991	7503
Degree-days, Sept. 1, 1935 to Mar. 31, '36	3286	972	4543	7176	3394	6563	8097
Degree-days, Sept. 1, to Mar. 31, Normal	2733	1255	3916	6578	2854	6208	7045

	Nashville, Tenn.	New Haven, Conn.	New Orleans, La.	New York, N. Y.	Norfolk, Va.	Oklahoma, City, Okla.	Omaha, Neb.
Degree-days for March, 1937	597	946	229	882	577	577	919
Degree-days, Sept. 1, 1936 to Mar. 31, '37	3255	4724	1059	4269	2769	3780	6184
Degree-days, Sept. 1, 1935 to Mar. 31, '36	3787	5115	1350	4689	3324	3714	6676
Degree-days, Sept. 1, to Mar. 31, Normal	3398	5129	1023	4707	3103	3451	5633

	Peoria, Ill.	Philadelphia, Pa.	Pittsburgh, Pa.	Portland, Me.	Portland, Oreg.	Providence, R. I.	Reading, Pa.
Degree-days for March, 1937	892	818	879	1043	475	941	857
Degree-days, Sept. 1, 1936 to Mar. 31, '37	5400	4055	4432	5620	3758	4786	4394
Degree-days, Sept. 1, 1935 to Mar. 31, '36	6119	4459	5079	5969	3944	5197	4897
Degree-days, Sept. 1, to Mar. 31, Normal	4535	4385	4734	6002	3732	5205	4876

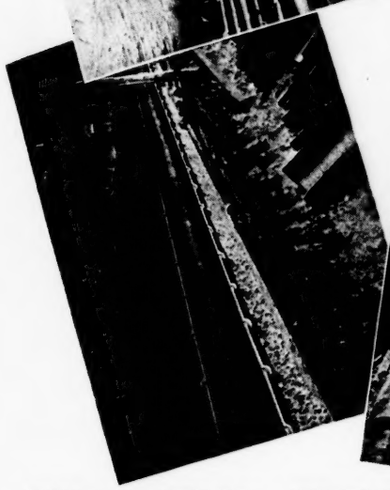
	Richmond, Va.	Rochester, N. Y.	St. Louis, Mo.	Salt Lake City, Utah	San Francisco, Calif.	Scranton, Pa.	Seattle, Wash.
Degree-days for March, 1937	632	1135	735	708	315	1044	499
Degree-days, Sept. 1, 1936 to Mar. 31, '37	3356	5487	4381	5319	2244	5182	3854
Degree-days, Sept. 1, 1935 to Mar. 31, '36	3857	6007	4904	4979	1890	5603	3904
Degree-days, Sept. 1, to Mar. 31, Normal	3485	5854	4309	4866	2124	5445	3932

	Spokane, Wash.	Syracuse, N. Y.	Toledo, Ohio	Trenton, N. J.	Utica, N. Y.	Washington, D. C.	Wichita, Kan.
Degree-days for March, 1937	704	1123	1021	878	1107	711	759
Degree-days, Sept. 1, 1936 to Mar. 31, '37	5989	5440	5364	4406	2160	3781	4631
Degree-days, Sept. 1, 1935 to Mar. 31, '36	5888	5974	6013	4879	6238	4281	4700
Degree-days, Sept. 1, to Mar. 31, Normal	5485	5984	5368	4450	5955	4253	4421

To obtain unit fuel consumption figures for any city shown above, multiply the number of degree-days by the following factors: for coal, 0.008; for oil, 0.00069; for gas, 0.096. Figures obtained will show coal consumption in pounds per square foot of radiator surface; oil consumption in gallons per square foot; gas consumption in cubic feet per square foot—all for the period covered by the number of degree-days. The figures assume the use of steam radiators emitting 240 B.t.u. per sq. ft. per hr., a system operation at 100% efficiency, and radiators calculated for maintaining 70° in zero weather. Heating values assumed for the fuels are 12,000 B.t.u. per lb. for coal; 140,000 B.t.u. per gal. for oil, and 1,000 B.t.u. per cu. ft. for gas. To correct for other heating values, efficiency and design conditions, follow the method explained in the "HEATING & VENTILATING Degree-day Handbook" or on H. & V.'s Reference Data Sheet Nos. 67 and 68. Degree-days as given above for a "normal" month or season are based on averages for a long period of years, ending about 1922. Averages covering different periods will disagree with the above figures slightly.

Atlanta University Housing Project, Atlanta, Ga.

University of Kentucky, Lexington, Ky.



Letterman General Hospital, San Francisco, Cal.

Moline Power Implement Co., Hopkins, Minn.

Thousands of Installations

—such as these—from coast to coast, bear witness to a national preference for Ric-wiL Underground Steam Conduit. Such confidence, on the part of engineers, architects, public officials, and owners, ***must*** be merited. Careful analysis of the basic features of Ric-wiL Tile or Cast Iron Systems, with incomparable Dry-paC Insulation, will convince ***you*** of Ric-wiL's better ***investment value.*** Write today for Installation Bulletin A3702.

THE RIC-WIL COMPANY
Union Trust Bldg., Cleveland, O.
New York San Francisco Chicago
Agents in principal cities

REGISTERED IN U. S. PATENT OFFICE
RIC-WIL
CONDUIT SYSTEMS FOR UNDERGROUND STEAM PIPES

Twenty years of experience in making heat regulating equipment are back of every

MASTER HEAT REGULATOR

Whether your customer belongs to the upper 400, or lives on Main Street, there is a Master Regulator that will satisfy him in quality and price, and pay you a satisfactory profit—for example:

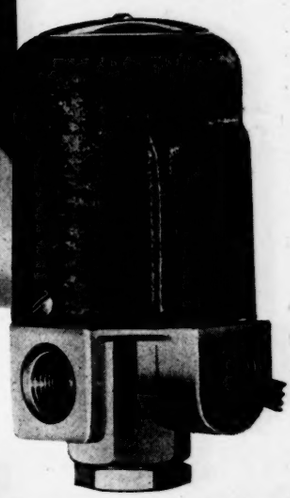
TYPE B-22 ***for only (to Dealer)*** **$13.50**

Silent, accurate, listed as Standard by Underwriters Laboratories. Just right for your biggest market—the moderate salaried home owner.

Write for Details TODAY

WHITE MANUFACTURING CO.
2364 University Ave., St. Paul, Minnesota

Easy to service



SOLENOID
CONTROL FOR AIR-CONDITIONING

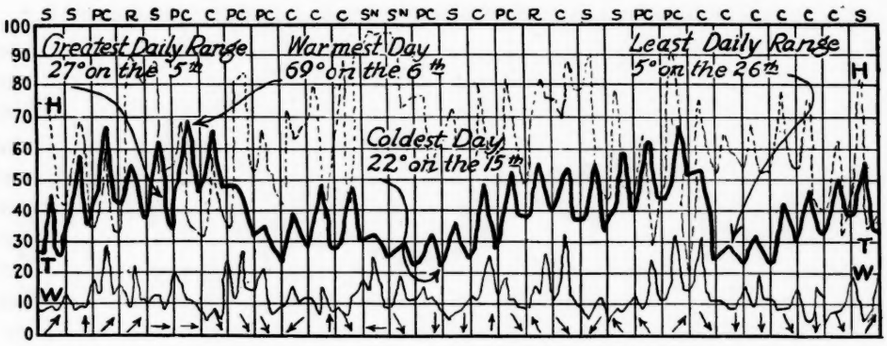
Easy to disassemble and service. New accessibility has been added to an already proven efficiency in this NEW A-P SOLENOID. Easily and quickly disassembled for inspection and cleaning.

Insist on A-P Solenoids for your air-conditioning equipment. Write for Bulletin on #73-RB.

AUTOMATIC PRODUCTS COMPANY
2462 NORTH THIRTY-SECOND STREET
MILWAUKEE WISCONSIN

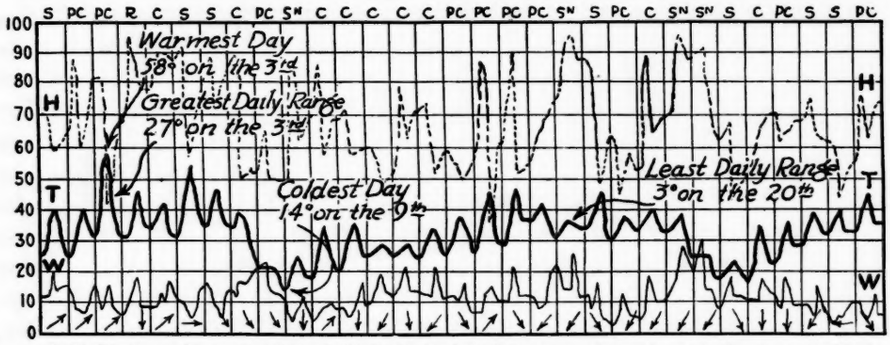
THE WEATHER FOR MARCH, 1937

Plotted from records compiled for HEATING & VENTILATING by the U. S. Weather Bureau. Heavy curves (T), dry bulb temperatures in deg. F.; dotted lines (H), per cent relative humidity from readings at 8 a.m., noon, and 8 p.m. Light lines (W), wind velocity in m.p.h. Arrows indicate prevailing wind directions, north being arrow pointing up, etc.; S—clear; PC—partly cloudy; C—cloudy; R—rain; Sn—snow.



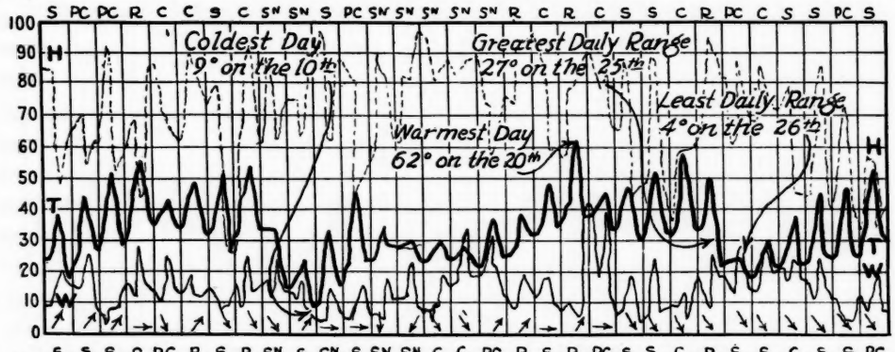
St. Louis

Mean temp. for month, 41.4F; aver. wind velocity, 11.5 m.p.h.; prevailing direction of wind, NW.



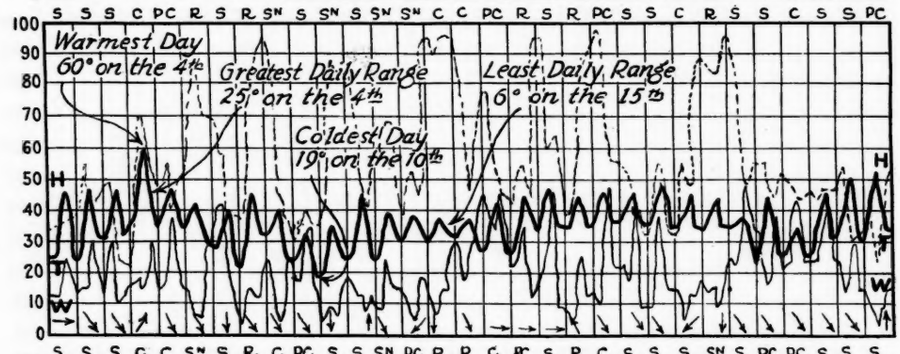
Chicago

Mean temp. for month, 32.8F; aver. wind velocity, 10.9 m.p.h.; prevailing direction of wind, NW.



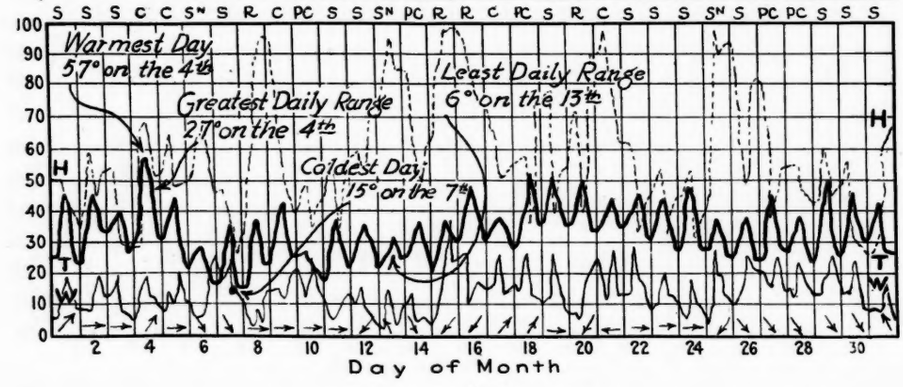
Pittsburgh

Mean temp. for month, 34.4F; aver. wind velocity, 12.9 m.p.h.; prevailing direction of wind, NW.



New York

Mean temp. for month, 36.6F; aver. wind velocity, 18.3 m.p.h.; prevailing direction of wind, NW.


Warmest Day
57° on the 4th
Greatest Daily Range
27° on the 4th
Coldest Day
15° on the 7th
Least Daily Range
6° on the 13th
2 4 6 8 10 12 14 16 18 20 22 24 26 28 30
Day of Month

Boston

Mean temp. for month, 34.1F; aver. wind velocity, 12.8 m.p.h.; prevailing direction of wind, W.

HERE IS A THOROBRED

PACEMAKER

IN THE

FAST MOVING FIELD OF

AUTOMATIC HEATING

THE AUTOMATIC BUTLER COAL STOKER

CONTINUES 400% SALES INCREASE PACE

Last year stoker sales increased 81%. Compare that to increases of 39% for oil burners and 28% for mechanical refrigerators. Consider well too the fact that last year sales of The AUTOMATIC BUTLER Coal Stoker were up nearly 400% over 1935.

14 SIZES

STANDARD STREAMLINED

SELF-COALING BIN-TO-BURNER

AND COMMERCIAL MODELS

WRITE AUTOMATIC BUTLER INTO YOUR SPECIFICATIONS

The line is complete. All models and sizes from 18 lb. per hr. to 1000 lb. per hr. capacities are highly engineered to handle a wider range of Automatic Heating at its best. Thousands are in use setting sales building performance records.

NATIONWIDE DEALER ORGANIZATION AT YOUR SERVICE

For complete data write direct to Stoker Division

BUTLER MANUFACTURING COMPANY

1272 EASTERN AVE., KANSAS CITY, MO.

WE USE

CHACE Thermostatic BIMETAL in the MULTI-BREAKER

SQUARE D COMPANY

DETROIT MICHIGAN

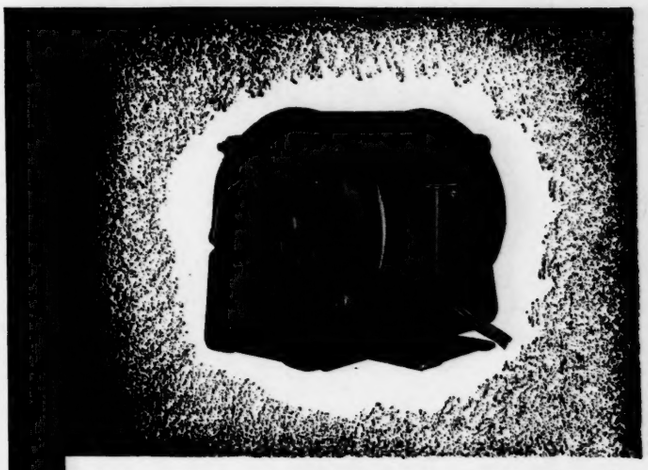
Chace Thermostatic Bimetal is the active element used in the Multi-Breaker to automatically prevent overloading circuits. Multi-Breaker takes the place of fuse box and fuses, yet its cost is comparable to that of a switch with customary fuses.

Where temperature is a factor, use Chace Thermostatic Bimetal as the active element to assure dependable automatic action.

Sold in sheets — strips — shapes.

W. M. CHACE CO.

1606 Beard Avenue - - - Detroit Mich.



REASONS WHY

Wagner Motors are Preferred for AIR CONDITIONING EQUIPMENT

1 ***They are reliable.*** All motor parts and completed motors are carefully tested to meet exacting specifications according to he highest electric motor standards—an assurance to users that Wagner motors are reliable, free from defects and will last a good long time if properly used.

2 ***They are economical.*** Actual tests show that Wagner motors consume very little electric current, do not require much care, and operate smoothly and easily under all types of load conditions.

3 ***They will give satisfactory service.*** Wagner motors of today are the result of constant improvement in their mechanical design and efficiency, gained by 45 years of experience in building and designing motors for industry and the home. These years of experience have enabled Wagner's engineers to determine the characteristics of motors that are best for satisfactory service.

4 ***They can stand rough treatment.*** Wagner motors have rolled-steel frames—strong, rigid—will not get out of alignment—unbreakable.

5 ***They require very little attention.*** The life of motors depends upon the conditions of operation to which they are subjected and the care they receive. Wagner motors are so constructed that wear between moving parts is reduced to a minimum. In addition, Wagner motors are equipped with large oil wells and have special lubrication systems so that only periodic oiling is necessary.

6 ***They are well-designed.*** Due to precision of manufacture, careful selection of materials and parts, and intelligent engineering, Wagner Motors have all the features that contribute to efficiency, and yet are unusually compact in design.

7 ***Convenient service facilities.*** Wagner maintains 25 branch offices, warehouses, and service stations in all parts of the country. Each branch carries a complete stock of parts available for immediate shipment. Thus, when there's trouble with any type of motor, Wagner can give better and quicker service.

The above are just a few of the many reasons why Wagner motors are preferred. Many motor buyers prefer Wagner motors because they know that the Wagner line is so diversified in types and ratings that they can get, without special designing, exactly the right motor for their job. Others prefer Wagner motors because they like the cooperation and helpful assistance the Wagner sales-engineers give them when solving their power-drive problems.

When considering your next motor application or installation problem, avail yourself of Wagner's service. Wagner engineers will be glad to work with you and help you select the correct motor for your job. Descriptive literature will be sent upon request.

MS 137-IL

Wagner Electric Corporation

6400 Plymouth Avenue, Saint Louis, U.S.A.

Refrigeration

Air conditions 16 theatres in Baltimore alone—and each installation is paying for itself in 2 to 3 years

Earning such returns is not unusual with Frick Refrigeration: restaurants increase profits up to 300 per cent; dairymen get Grade A prices for their milk; ice cream and quick freezing plants save up to 34 per cent in horsepower consumed; one-man ice plants produce and store up to 22 tons of ice per day; 50 other businesses find it equally indispensable.

Give your business the advantage of Frick cooling service. Ask for full facts and figures today.

WAYNESBORO, PENNA. U.S.A.
FRICK CO.
DEPENDABLE REFRIGERATION SINCE 1882

WITH THE MANUFACTURERS

The American Foundry Equipment Co., Mishawaka, Ind., has appointed *Charles Rutledge* as service representative for the Detroit district, with headquarters with Hutton H. Haley & Associates, 2918 E. Grand Blvd.

Anthracite Industries, Inc., New York, has appointed *A. F. H. Scott* assistant to president. Mr. Scott will have charge of the work with manufacturers in the development, improvement, and merchandising of anthracite-burning equipment and the application of new uses for anthracite. He is a graduate of the University of Wisconsin engineering school, and during the past six years has been assistant sales manager of American Radiator Co., New York. For the past two years, he was loaned to the Federal Housing Administration in Washington by American Radiator.

Armstrong Cork Co., Lancaster, Pa., has elected *C. Dudley Armstrong* vice-president and secretary, succeeding William R. Hamilton, who recently retired. *H. R. Peck* was elected to the board of directors. *John P. Young* has been named advertising manager, succeeding Arthur K. Barnes. *Ralph Winslow* has been appointed assistant advertising manager.

The Bodine Electric Co., Chicago, has appointed *H. M. Hall*, 108 W. 6th St., Los Angeles, Calif., representative in the southern part of that state.

Gar Wood Industries, Inc., Air Conditioning Div., Detroit, has named *Leon C. Hulse* factory sales engineer. His new work includes supervisory engineering duties and participation in general sales activities. Mr. Hulse has been connected with the air conditioning division for the past six years.

Gar Wood Industries, Inc., Air Conditioning Div., Detroit, has appointed *R. J. Owen, Joseph F. Pope*, and *Arthur C. Bader* to the Detroit branch air conditioning sales staff.

General Refractories Co., Philadelphia, has appointed *H. W. Porter & Co., Inc.*, Newark, N. J., as distributor in the Newark area.

The Insulite Co., Minneapolis, Minn., has appointed *T. J. Lindstrom*, formerly manager of the northeast sales district, as manager of western industrial sales. *O. R. LeVene* has been named manager of eastern industrial sales.

The International Boiler Works Co., Inc., East Stroudsburg, Pa., has elected *Ernest H. Taylor* vice-president in charge of production. He will have complete charge at the factory. *John B. Kingsley* is now vice-president in charge of sales, with headquarters in the New York City sales office at 101 Park Ave. Frank B. Metcalf is no longer a director of the company.

Link-Belt Co., Stoker Div., Chicago, has appointed *H. F. Brown* manager of sales of its electronic Radiostat control system. At its recent annual meeting of stockholders, the following directors were elected: *Bernard E. Sunny, James S. Watson, Staunton B. Peck* and *Harris Whittemore, Jr.*, were re-elected.

Mayflower-Lewis Corporation of St. Paul has been formed merging Mayflower, Inc., formerly of Lima, Ohio, and the Lewis Air Conditioning Co., Minneapolis. This merger joins the executive and engineering staffs, and officers of Mayflower-Lewis are: President, *Harry J. Hunt;* vice-president, *Lawrence M. Butler;* treasurer, *Fred C. Geiler;* secretary, *James E. Knight;* chief engineer, *Stanley C. Marshall.*

Modine Manufacturing Co., Racine, Wis., has acquired a substantial interest in the *Syncromatic Air Conditioning Corp.*, Milwaukee. National distribution of Modine-Syncromatic air conditioning equipment will be made through the Modine sales organization. Syncromatic, which at present is manufacturing this equipment for Modine, will contine to do research and development work it has been carrying on since its inception.

Neemes Foundry, Inc., Troy, N. Y., has named *M. Abbott's Sons, Inc.*, 20 W. 22nd St., New York, as its sole representative in the metropolitan area.

The Herman Nelson Corp., Moline, Ill., has moved its Chicago office to *540 N. Michigan Ave. C. A. Pickett*, for 17 years manager of the company's St. Louis office, has been appointed manager.

Portland Gas & Coke Co., Public Service Building, Portland, Oreg., has named *C. W. Steele* residential sales manager of its commercial department. Mr. Steele will have charge of the residential sales crew of 35 salesmen in the Portland area and 15 salesmen in other towns served by the company.

Standard Lime & Stone Co., Insulation Div., Baltimore, Md., has appointed *Oliver P. Harris* assistant general manager in charge of sales of Capitol rockwood home insulation.

Surface Combustion Corp., Toledo, Ohio, has appointed the following Janitrol field representatives: *Wallace Adams* has been named for the Kansas City office; *Herbert A. Gross* will be stationed in Minneapolis; *Ernest Smart* will work in Westchester Co., New York; *Lawrence J. Monahan* will be the Buffalo, N. Y., representative; *Raymond E. Vernon* will work the Atlanta territory; *DeWitt T. Preyer,* Brooklyn; *Guy F. Brown,* Chicago; *Charles F. Schlichter,* Washington, and *Harry Reid* has been placed in the Chicago office territory.

H. A. Thrush & Co., Peru, Ind., has added *Thos. E. Fahy, Jr.*, to its Philadelphia branch factory sales staff.

Young Radiator Co., Racine, Wis., has added *Sidney Smith* to its production staff. Mr. Smith was formerly with Studebaker Corp. and later with Banton Roller Bearing Co.

3125 Sarco Traps *in this Federal Housing Project*

Cedar Central Housing Project, Cleveland, pictured here, is one of the largest sponsored by the Federal Housing Administration. It includes 654 apartments, 80 garages, nine stores and a children's playground 100 by 250 ft.

As our insert shows, the buildings are modern in design and many of the newest ideas for better living are included in the interior arrangements.

Not the least of these is the Sarco Heating System employed in all of the 19 buildings. Its selection is an expression of the confidence placed in Sarco Heating Specialties by the Government, the architects and W. G. Cornell Co., the contractors.

For efficient, silent and trouble-free heating, insist on Sarco Radiator Traps, Inlet Valves, Drip Traps, Air Eliminators, etc.

Write for our interesting Catalog P-45.

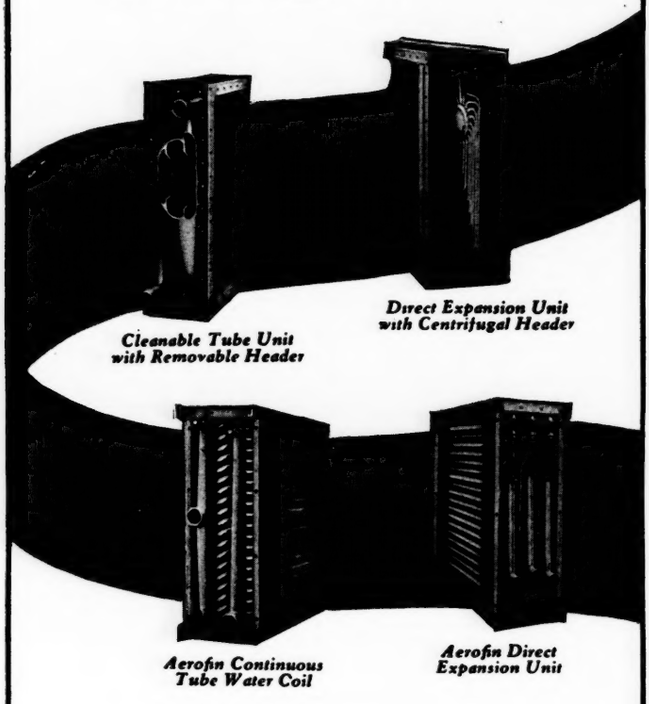
SARCO CO., INC.

183 Madison Ave., New York, N. Y.

Branches in Principal Cities
Sarco Canada Limited, Federal Bldg., Toronto, Ont., Canada.

SARCO HEATING SYSTEM

For Dependable
COMFORT COOLING
Specify
AEROFIN
Cooling Surface



Cleanable Tube Unit with Removable Header

Direct Expansion Unit with Centrifugal Header

Aerofin Continuous Tube Water Coil

Aerofin Direct Expansion Unit

A COMPLETE LINE
For Every Requirement

AEROFIN CLEANABLE TUBE UNITS: For cooling only. Headers removable to permit cleaning of tube interiors. Recommended where sediment or scale-forming chemicals are present in cooling water.

AEROFIN DIRECT EXPANSION UNITS: Centrifugal header type. Recommended where one valve control of unit is desired.

AEROFIN CONTINUOUS TUBE WATER COILS: For air cooling by circulation of cold water through tubes. Made for horizontal or vertical air flow.

AEROFIN DIRECT EXPANSION UNITS: Row control type. For use where cutting rows of tubes on or off in direction of air flow is desired.

Ask Newark for complete descriptive literature and data or call on the nearest district office for technical assistance.

AEROFIN is sold only by Manufacturers of Nationally Advertised Fan System Apparatus. — List upon Request

AEROFIN CORPORATION
810 FRELINGHUYSEN AVENUE
NEWARK, N. J.
Chicago · Detroit · New York · Philadelphia · Dallas · Atlanta

NEW CATALOGS

(Unless otherwise indicated the publishers of catalogs will supply copies on request without charge.)

AIRTHERM MANUFACTURING CO., 1474 S. Vandeventer Ave., St. Louis, Mo., has published a standard-size, 16-page bulletin covering their Airheater line of centrifugal fan heaters. The Airheater is a heater for large area installation and is available for floor setting or ceiling suspension. Gives specifications, dimensions, and installation data.

AMERICAN RADIATOR CO., 40 W. 40th St., New York, has published a standard-size, eight-page bulletin which gives general information covering the selection and application of Ideal boilers for automatic coal firing. Bulletin presents information on the grading of stoker boilers, selecting stoker boilers, and the features of Ideal boilers for stoker firing.

THE BROWN INSTRUMENT CO., Philadelphia, Pa., has published a standard-size catalog, No. 2004, on its flow meters. The catalog covers the complete line of indicating, recording and integrating instruments, in both electrical and mechanical types, together with the Brown Air-o-Line flow and liquid level controllers. It explains their application to power as well as to general industrial use.

CANTON STOKER CORP., Canton, Ohio, has published a standard-size bulletin, No. 30-G3, which describes its new purchase plan by which its equipment is insured for five years against defects and wear. Bulletin also describes features of construction and shows the various types of stokers manufactured.

DAVIS REGULATOR CO., 2541 S. Washtenaw Ave., Chicago, has published a pressure regulator service chart. This chart tabulates the features of various Davis pressure regulators as an aid in selecting the proper valve for given conditions.

THE MERCOID CORP., 4201 Belmont Ave., Chicago. A standard-size bulletin describing the Mercoid line of automatic controls. Discusses the Sensatherm thermostat, "K" line safety controls, pressure limit and low water controls for steam boilers, hot water temperature limit controls, warm air furnace controls, and sealed mercury contact switches.

MODINE MANUFACTURING CO., Racine, Wis., has published a standard-size, 32-page catalog, No. 136, entitled "Better Heating and Air Conditioning with Modine Copper Convectors." The booklet is attractively printed and has a black and copper cover. Among the subjects discussed are the truth about heating and air conditioning, the split system of air conditioning, and why copper convectors. Gives data on Modine concealed, recessed, floor cabinet and wall cabinet convectors and enclosures. Includes information on capacity, dimensions, and installation data.

THE MOTOR EQUIPMENT CO., Wichita, Kan. Two standard-size bulletins on the Strang evaporative condensers. The first bulletin, which has four pages, lists the main features and specifications of the Strang evaporative condensers while the second bulletin, which has 11 pages, gives technical data on the unit. This latter bulletin describes the cycle of operation, instruction details, lists installation instructions, and gives specifications and ratings.

MUELLER BRASS CO., Streamline Pipe and Fittings Div., Port Huron, Mich. A fact-finding report on Streamline joints employing locking wire. This report made by the Underwriters' Laboratories covers tensile tests conducted on Streamline tubing and fittings employing the joints incorporating a locking wire. Bulletin is standard size. Numerous photographs illustrate the fittings tested.

PEERLESS OF AMERICA, INC., 515 W. 35th St., Chicago. A 36-page, standard-size, loose-leaf catalog commemorating the 25th anniversary of the company. Catalog lists the complete line of Peerless products and presents features, specifications, and engineering data on the various products. An excellent description of refrigeration cooling coils is incorporated in the front part of the catalog. Among the products described are Peerless fin transfer coils; animal hair filters; Helicon fans; comfort coolers, both ceiling and floor type; air conditioning coils; water savers; and thermal expansion valves.

PRACTICAL INSTRUMENT CO., 2717 N. Ashland, Chicago. A new folder describing portable recording thermometers and electrical operating recorders

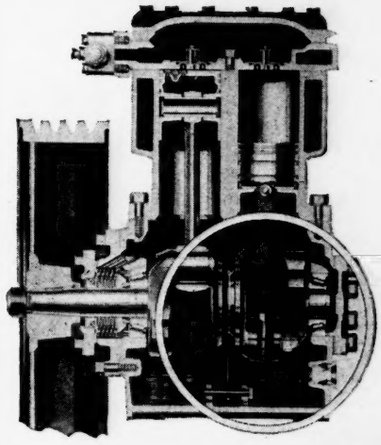
ROSS HEATER & MFG. CO., INC., 1407 West Ave., Buffalo, N. Y., has published a standard-size, 24-page bulletin, No. 1062. This bulletin describes the Ross line of instantaneous heaters, gives dimensions, capacities, and specifications. The capacity tables are unusually complete and cover approximately 10 pages.

SHELL PETROLEUM CORP., Shell Bldg., St. Louis, Mo. The first three booklets of a series entitled "Panorama of Lubrication." Booklets are standard size and are attractively printed. The purpose of the series is to furnish non-technical information in regard to the manufacture and application of lubricants.

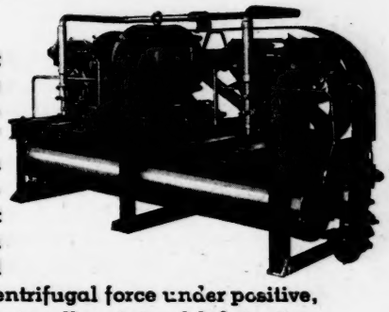
STERLING ENGINEERING CO., 3738 N. Holton St., Milwaukee, Wis., has published a standard-size catalog, No. 361, describing the Sterling temperature control. The bulletin discusses the Sterling system of controled steam heating and gives insulation data, specifications, dimensions and construction information on the Thermotrol.

THE VIBRATION ELIMINATOR CO., 41-26 37th St., Long Island City, N. Y., has published an 18-page catalog entitled "Stop Vibration." This catalog discusses the problem of machinery isolation, presents data on the various types of vibration eliminators made by this company, and shows a number of typical installations.

CURTIS
Condensing Units



"CENTRO-RING" LUBRICATION—
—only
CURTIS COMPRESSORS
have it



THERE'S just one moving part in Curtis "Centro-Ring" lubrication—a simple, free running ring that picks up oil from the crankcase and distributes it by centrifugal force under positive, uniform pressure to all points of lubrication—no gears—no plungers—nothing to get out of order or require service.

Engineering superiorities of this kind have built the Curtis reputation for reliability, long operating life and low cost of upkeep.

The Curtis line contains 41 air-cooled units, from 1/6 HP to 5 HP, inc., and 45 water-cooled units from 1/3 HP to 30 HP — a size and type to balance most any installation you might make. Curtis has built condensing units for 15 years and has made engineering equipment for 82 years — a record of success that in itself is sufficient warranty of the high-quality of Curtis units of today.

CURTIS Engineering Refinements

- Centro-Ring — one piece, positive pressure lubrication
- Timken Tapered Roller Bearings
- V-type radial compressor
- Water-jacketed compressor heads and cylinders
- Built-in oil separator with automatic return
- Drop forged, heat treated crankshafts and rods
- Balanced syphon, bellows seal
- Automatic water valves

Represented in Canada by
Canadian Curtis Refrigeration Co., Ltd.
20 George St., Hamilton, Ont., Can.

CURTIS REFRIGERATING MACHINE CO.
"Builders of Condensing Units since 1922"
1958 Kienlen Ave., St. Louis, U. S. A.

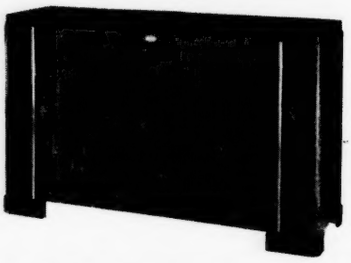
Splitting Up The Split System of Air Conditioning

DON'T mistake us. Have no intentions of knocking Split Systems. They do a good job.

But frankly, we prefer reaching the same results in a different way. A way that's *simpler*. A way that requires *no ducts*. A way that needs *no tinsmithing*. A way that *costs less* than other ways.

As radiator heat is accepted as the best all around heat why split it up with a combination of Warm Air?

So we took a radiator and designed an air conditioner about it, that takes the place of any regular radiator. Piping connections are the same. No tinsmithing. No cutting of walls or floors for registers or grilles. It is as practical for old systems of radiator heat as for new. Two conditioners will air-condition a 7-room house. Send for Catalog. Get the full facts. See for yourself.



This is the Air Conditioner that takes the place of a radiator. It filter-cleans the air, heats and humidifies it, and then circulates it. Any steamfitter can install it. No tinsmithing. Two will air-condition the average 7-room house.

BURNHAM BOILER CORPORATION
IRVINGTON, NEW YORK
ZANESVILLE, OHIO

Foreign Export Department
116 Broad St., New York.

Burnham Boiler

COMING EVENTS

MAY 12-13, 1937. SPRING MEETING, REFRIGERATING MACHINERY ASSOCIATION, *Hot Springs, Va.*

MAY 12-23, 1937. NORTH AMERICAN HOMES EXPOSITION, *Madison Square Garden, New York, N. Y.*

MAY 14-15, 1937. ANNUAL MEETING, AIR CONDITIONERS' ASSOCIATION, *Hot Springs, Va.*

MAY 17-19, 1937. 48TH ANNUAL CONVENTION OF THE HEATING, PIPING AND AIR CONDITIONING CONTRACTORS NATIONAL ASSOCIATION, *Hotel Nicollet, Minneapolis, Minn.*

MAY 24-26, 1937. 11TH GENERAL MEETING, NATIONAL BOARD OF BOILER AND PRESSURE VESSEL INSPECTORS, *Hotel McAlpin, New York.*

MAY 24-27, 1937. 55TH ANNUAL CONVENTION OF THE NATIONAL ASSOCIATION OF MASTER PLUMBERS, *Atlantic City, N. J. Convention headquarters at the Ambassador Hotel. In connection with the convention, The 1937 Home Comfort Exposition will be held in the Atlantic City Auditorium.*

MAY 25-27, 1937. SPRING MEETING OF THE AMERICAN SOCIETY OF REFRIGERATING ENGINEERS, *French Lick Springs, Ind.*

MAY 25-27, 1937. 4TH SHORT COURSE IN COAL UTILIZATION, *University of Illinois, Urbana, Ill.*

MAY 25-28, 1937. ANNUAL CONVENTION OF THE NATIONAL DISTRICT HEATING ASSOCIATION, *Detroit, Mich.*

JUNE 1-4, 1937. 31ST ANNUAL CONVENTION OF THE SMOKE PREVENTION ASSOCIATION, INC., *Hotel Pennsylvania, New York. Fuel burning and air pollution exhibition to be held in ballroom of the hotel, May 31-June 5.*

JUNE 1-4, 1937. ANNUAL MEETING, AMERICAN INSTITUTE OF ARCHITECTS, *Hotel Somerset, Boston, Mass.*

JUNE 1-4, 1937. ANNUAL MEETING OF THE EDISON ELECTRIC INSTITUTE MEETING, *Palmer House, Chicago, Ill.*

JUNE 4-5, 1937. MEETING STOKER MANUFACTURERS ASSOCIATION, *White Sulphur Springs, W. Va.*

JUNE 9-10, 1937. MID-YEAR CONVENTION OF THE NATIONAL WARM AIR HEATING & AIR CONDITIONING ASSOCIATION, *Hotel Cleveland, Cleveland, O.*

JUNE 21-24, 1337. 31ST ANNUAL MEETING, AMERICAN SOCIETY OF AGRICULTURAL ENGINEERS, *Urbana-Lincoln Hotel, Urbana, Ill. Registration Headquarters, Women's Building, University of Illinois.*

JUNE 21-24, 1937. NATIONAL CONVENTION AND EXHIBIT. NATIONAL ASSOCIATION OF BUILDING OWNERS AND MANAGERS, *Buffalo, N. Y.*

JUNE 23-26, 1937. SEMI-ANNUAL MEETING OF THE AMERICAN SOCIETY OF HEATING & VENTILATING ENGINEERS, *New Ocean Hotel, Swampscott, Mass.*

JUNE 28-JULY 2, 1937. ANNUAL MEETING AND EXHIBIT OF TESTING APPARATUS, *American Society for Testing Materials, The Waldorf-Astoria, New York.*

AUGUST 3-7, 1937. POWER SHOW AND MECHANICAL EXPOSITION, *The Universal Craftsmen Council of Engineers of the World, Hotel Stevens, Chicago, Ill.*

AUGUST 30-SEPTEMBER 3, 1937. NATIONAL CONVENTION, NATIONAL ASSOCIATION OF POWER ENGINEERS, INC., *Jefferson Hotel, St. Louis, Mo.*

SEPTEMBER 27-OCTOBER 1, 1937. 19TH ANNUAL CONVENTION OF THE AMERICAN GAS ASSOCIATION, *Hotel Cleveland, Cleveland, Ohio.*

OCTOBER 4-9, 1937. CHICAGO EXPOSITION OF POWER & MECHANICAL ENGINEERING, *International Amphitheatre, Chicago, Ill.*

OCTOBER 5-8, 1937. 66TH ANNUAL MEETING OF THE AMERICAN PUBLIC HEALTH ASSOCIATION, *New York City.*

DECEMBER 5-10, 1938. THIRTEENTH NATIONAL EXPOSITION OF POWER AND MECHANICAL ENGINEERING, *Grand Central Palace, New York.*

DECEMBER 6-11, 1937. 16TH EXPOSITION OF CHEMICAL INDUSTRIES, *Grand Central Palace, New York.*

JANUARY 24-28, 1938. FIFTH INTERNATIONAL HEATING AND VENTILATING EXPOSITION, *Grand Central Palace, New York.*

JANUARY 24-28, 1938—44TH ANNUAL MEETING, AMERICAN SOCIETY OF HEATING & VENTILATING ENGINEERS, *New York.*

TOOK **21 YEARS TO DESIGN** THIS

MODINE

BLAST HEATER

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